EVALUATION OF OCCUPATIONAL EXPOSURE TO WASTE ANESTHETIC GASES IN ONTARIO HOSPITALS

A report of a Study Conducted by Staff
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EXECUTIVE SUMMARY

Exposure of workers to waste anesthetic gases in the operating and recovery rooms of hospitals is an ongoing concern because a number of epidemiological and mortality studies have reported significant adverse effects.

Reproductive effects, which include spontaneous abortion and congenital abnormalities have been reported in women directly exposed to anesthetic gases, and indirectly through marriage to exposed men.

Chronic disease hazards wnich have been studied in the exposed population include cancer, liver and renal diseases but the results have been inconclusive. Some reviewers believe there is convincing evidence, while others believe the data are inconsistent and flawed.

NIOSH has recommended exposure levels for ambient levels of anesthetic gases in the operating room to diminish the risk of foetal wastage and congenital malformation among offspring, and to reduce the likelihood of direct toxic and hypersensitivity effects among operating room staff.

To evaluate the health risks if any, and to assist in the development of guidelines or regulations for the hospital sector in Ontario, the Occupational Health Branch (now named the Health and Safety Support Services Branch) of the Ontario Ministry of Labour conducted this extensive study.

The objectives of this study were:

1. To review the occupational health concerns of workers exposed to waste anesthetic gases in hospitals and determine whether it supports the findings in the literature, by means of a Questionnaire Survey.

2. To review the waste anesthetic gases exposure levels in Ontario hospitals, by conducting industrial hygiene surveys on a representative sample of Ontario hospitals.

3. To recommend corrective measures to control workers exposure to anesthetic gases.

The Questionnaire used by the Occupational Health Branch incorporated the one used by the American Society of Anesthesiologists (ASA) in order to compare both study findings. The Questionnaires were administered by the Occupational Health Branch nurse consultants during the period 1981 - 1985 in one-hundred hospitals throughout Ontario. The returned questionnaires totalled 10,557, giving a response rate of 78.8% for the exposed group, and 87.2% for the non-exposed control group.

A walk-through survey of all locations of potential exposure to anesthetics was conducted by an industrial hygienist in a representative sample of 74 hospitals providing Surgical Services in Ontario (approximately 40% of the 195 non-Federal hospitals). Air sampling was conducted, observing operating room protocol, and it included long-term air sampling for halocarbon vapours (halothane,

enflurane and isoflurane), and nitrous oxide sampling by direct reading instruments. The industrial hygiene assessments included an evaluation of the mechanical dilution ventilation, the scavenging system and documentation of the equipment used to administer anesthesia at the time of the assessment.

Prior to this study, the Ministry had no reference standard for anesthetic gas exposures. It has always been claimed in the literature that the usual ratio of nitrous oxide to one of the halocarbon vapours in an anesthetic mixture administered to the patient is 50:1. Based on the health effects review in this report, the Ministry adopted the NIOSH recommended time-weighted average exposure values of 25 ppm for nitrous oxide and 2 ppm each independently for the halocarbon vapours. The ACGIH suggested values for halocarbon TLVs were considered to be inappropriate, since it did not take into account the anesthetic mixture ratio, and may allow unacceptably high concentrations of nitrous oxide. It should be noted however, that the Ministry modified the NIOSH values to reflect averaging over an 8 hour period rather than 1 hour or the period of the operation as suggested by NIOSH. This was necessary because although 67% of the operations observed took less than 1 hour (the duration of surgical operations ranged from 15 - 480 minutes), the exposure time of operating room personnel, such as nurses and anesthetists, was not limited to one operation but covered a number of operations per 8 hour workday.

Statistical analysis of the Health Questionnaire data suggested a positive association between exposure to anesthetics and spontaneous abortion in exposed female workers and an increased risk of congenital

abnormality in their offspring, which is in agreement with previous studies. The data also suggested an association of increased risk of adverse reproductive outcome in wives of exposed personel. No association was found between exposure to anesthetics and the incidence of chronic disease i.e. Cancer/leukemia, liver and kidney diseases. Due to the limitations imposed by the design of the study, it was not possible to confirm a dose-effect relationship. Other health effects were not positively associated with exposure to anesthetics.

The results of the hygiene study show that exposure to waste anesthetic gases occurs due to leaks in the anesthetic equipment. The three major sources of leaks (i.e. exhalation valve, mask and high pressure fittings) caused results above the upper limit of detection of Nitrous Oxide (1,000 ppm of N_2O) in a significant number of samples. The leak source sampling at the exhalation valve had the highest percentage of samples above 1,000 ppm, which suggested that scavengers were not receiving proper service and maintenance. Only 23% of the operating rooms surveyed met the Ontario Ministry of Health criteria of 24 air changes/hour. The effect of dilution ventilation on air contaminants was not as effective as scavenger systems.

Air sampling results taken at the exhaust grille, representing gases exhausted from the room, correlated with personal exposure values except for the anesthetists. The median personal exposure of all workers to halothane was 0.01 ppm, to enflurane 0.40 ppm and to isoflurane 0.60 ppm, thus all were well within the exposure standard of

2 ppm. The N_2O time-weighted average exposure median value was 37.6 ppm while the mean was 86.3 ppm, so both were above the exposure standard of 25 ppm. Nitrous oxide exposure was found to exceed the standard value in most operating rooms.

The air sampling results were not correlated with the reported health effects in the questionnaire because the latter reflected findings attributable to earlier exposures. It has to be noted however, that there is a strong suggestion in the literature to associate nitrous oxide exposure with spontaneous abortion in females exposed during pregnancy.

In order to achieve acceptable control of waste anaesthetic gases the report recommends that:-

1. The dilution ventilation rate of 24 air changes/hr., as recommended by the Ontario Ministry of Health, should be provided in all operating rooms.

2. No recirculation of exhaust air should be permitted during the hours when operations are in progress. Consideration may be given to recirculating the air during non-operating hours.

3. Scavengers should be provided in all operating rooms to control gas release from the expiratory valve in the anaesthetic circuit or equivalent in the ventilator.

4. Maintenance in each hospital should be the responsibility of a qualified staff member adequately trained in the repair and maintenance of anaesthetic delivery systems. A high and low pressure leakage testing programme should involve, testing the equipment every four months and slip-over connections weekly. Also, testing of the effectiveness of the scavenger at the time of installation and periodically thereafter.

5. A qualified staff member should be responsible for conducting periodic personal monitoring in ORs and RRs and the sampling strategy should include individuals and the exhaust grilles.

6. N_2O exposure assessments can probably represent the adequacy of controls for all anesthetic gases.

LITERATURE REVIEW - TOXICOLOGY AND HEALTH EFFECTS

It is common practice to use a mixture of nitrous oxide and halocarbon anesthetics (Halothane, Enflurane and isoflurane) to anesthetise patients for surgery. The literature contains a number of reports on the toxicity of the commonly used anesthetics, and they may be summarized as follows:-

NITROUS OXIDE

Effect on Hemopoetic System:

In animals it is known that leukopenia with a predominence of lymphocytes is an acute effect of nitrous oxide[1]. In humans, prolonged anesthesia with nitrous oxide may produce leukopenia which may progress to aplastic anemia. Fatal aplastic anemia also occurs in animals[2],[3]. Recently, megaloblastic changes in the bone marrow of patients receiving nitrous oxide were reported in two studies[4],[5].

Effect on Nervous System

The effects of Nitrous oxide in different concentrations on psychometric performance as measured by cognitive testing was reviewed by Smith & Shirley[6], and concentrations of nitrous oxide from 50-500 ppm have been shown to produce easily observable adverse effects on digit span[7],[8], cognitive tasks[9], and disturbances in memory and time sense[10],[11].

Statistically significant decrements in performance were observed with exposures as low as 50 ppm of nitrous oxide, irrespective of the simultaneous presence of halogenated anesthetic[7,8,12]. The most impaired functions reported included visual perception, recent memory, and the combination of perception, cognition and motor responses when responding to simultaneous visual and auditory stimuli. These effects were absent when exposure to nitrous oxide did not exceed 25 ppm. This finding is the basis for the NIOSH recommendation to limit exposure to nitrous oxide to 25 ppm.

Peripheral neuropathy has also been reported with abuse of nitrous oxide [13]. This is probably secondary to the oxidizing effect of nitrous oxide on vitamin B_{12},[14].

Embryotoxic and Teratogenic Effects

Short-term exposures to nitrous oxide have been shown to be embryotoxic and teratogenic in rats[15,16,17,18], in Chicks[19,20] and in Hamsters[21]. On chronic exposure of gravid rats, reproductive effects were observed[22,23,24].

Mutagenic & Carcinogenic Effects

Nitrous oxide is weakly mutagenic in Tradescantia[25]. A sex-linked mutation of sperm cells has been observed with the dominant lethal test in Drosophila Melanogaster[26]. In male rats, chronic exposure to nitrous oxide affected spermatogenesis[27].

HALOTHANE (Fluthane)

Biotransformation:

Halothane causes anesthesia at an exposure level of 10,000 ppm.. 15-20% of the Halothane absorbed is metabolized to fluorides, through an intermediate difluorochlorobromoethylene.

Effect on Myocardium

Depression of myocardial function from Halothane is well known[28], with arrhythmias and vasodilatation.

Effect on Liver

Acute exposures in anesthetic concentrations may result in hepatitis due to either a direct hepatotoxic effect or though an immunological reaction[29,30,31,32]. The exact chemical nature of the reactive intermediate which is responsible for the liver toxicity is not known, but it may be either the difluorochlorobromoethylene or the Halothane free radical,
or both [19,33].

Chronic exposure to Halothane causes hepatotoxicity with increase of liver enzymes in man and animals[34,35,36,37].

Fatty infiltration and degenerative changes due to chronic Halothane exposure have been observed in mice, rats, guinea pigs and rabbits [38,39,40]even when rats were exposed in utero[41]. It has been suggested that hepatic microsomal enzymes only appear in humans when occupational exposure exceeds a time-weighted average of 2 ppm[42].

Effect on Kidneys

Chronic exposure to Halothane has been reported to cause cellular structural changes in the kidney of animals[43] and in the neonatal kidney following in-utero exposure[44].

Effect on Nervous System:

Cellular structural changes in the nervous system after chronic exposure to Halothane have been reported[45]. The brain changes were found to be associated with residual behavioural deficits[46],[47].

Embryotoxic and Teratogenic Effects

Over exposure to Halothane is embryotoxic and/or teratogenic in rats, [48]guinea pigs[49] and chicks[50]. Cleft palate was induced by Halothane anesthesia in C-57 Black Mice[51].

Mutagenic and Carcinogenic Effect

Chronic exposure to Halothane has been found to be border-line mutagenic in Drosophila[52]. No carcinogenic effects from Halothane have been reported in animal studies[28].

ENFLURANE (Ethrane)

Biotransformation

Exposure to 15-20 thousand ppm of Enflurane causes anesthesia. 2.4% of enflurane is dehalogenated at the terminal dihalocarbon to a fluride ion, chloride ion, and tetrafluorocarboxylic acid.

When the toxic effects are compared to Halothane, Enflurane is less toxic on the myocardium and the liver, however has a unique effect on the brain causing seizures[28]. It is not nephrotoxic despite releasing fluoride ions when metabolized, and this is because of their very slow release[33].

Abnormalities in cognitive skills have also been reported with over exposure to Enflurane[7].

Embryotoxic and Teratogenic Effects

Embryotoxicity has been demonstrated in pregnant mice exposed to 1% Enflurane thoroughout pregnancy[53]. Mice exposed for twenty hours showed abnormal spermatozoa[54] and [55].

Mutagenic and Carcinogenic Effects

There is no experimental evidence that Enflurane is mutagenic or carcinogenic.

ISOFLURANE (Forane)

This is a relatively new anesthetic which is a stuctural isomer of Enflurane, so knowledge of any adverse health effects with this agent is still limited.

Biotransformation

Less than 0.2% of isoflurane is metabolized but this causes a slight increase in fluoride aud trifluoroacetic acid in the urine[33,56]. The uptake and clearance of isoflurane has been compared to other anesthetics and it is considered to be safer[57].

Mutagenic and Carcinogenic Effects

Early reports in the literature on it's carcinogenicity have not been well substantiated[58,19].

METHOXYFLURANE (Penthrane)

This is a slow-inducing anaesthetic and is less frequently used than other Halogenated agents[59].

Biotransformation

50% of the methoxyfluorane absorbed is metabolized to fluorides and oxalic acid.

Effect on Kidney

Nephrotoxicity has been reported with methoxyfluorane[60,61,62,63,64,65].

Effect on Liver

Effects on the liver have been reported with the use of methoxyflurane[62].

Mortality Studies

Three mortality studies have been noted in the literature. Two were conducted in the U.S. by the same authors[66,67], for the periods 1947-1966 and 1967-1971, the second being a prospective extension of the earlier study. The third study was conducted in Great Britain[68], for the period 1951-71.

The U.S. studies compared the American Society of Anesthesiologists (ASA) members with U.S. white males in the first study, and with life insurance policy holders in the second. In the British study, male anesthesiologists were compared with other male doctors. The method of data collection in the U.S studies was from the ASA records, while in the British study the data were obtained through questionnaires.

In the first U.S. study[66], the information collected was on 441 deaths among male members (junior, active or retired) of the ASA between 1947-1966. The investigation determined the principal cause of death in each case and calculated age-specific death rates. These were then compared with death rates among both white male policy holders of Metropolitan Life and all white males in the U.S. The main finding from this study was a substantially increased death rate from lymphoid and reticuloendothelial malignancies (17 observed vs 8.9 expected among all white U.S. males). However, the authors pointed out that the number of deaths from each cause were very small and the findings may have been due to chance.

In the follow-up study[67] this finding was not confirmed.

The English study[68] reported on the mortality of a cohort of physicians established in 1951 to study the health effects of smoking. All reported deaths between 1951 and 1971 were assigned a cause, and categorized according to different occupational specialities including anesthesiology. The investigators then calculated the ratio of the number of deaths observed to the number expected if occupation had no effect on type of mortality. These standardized mortality rates for each occupation were then compared for each cause of death. There was an excess of pancreatic cancer deaths among full-time anesthesia specialists, which was not found among part-time anesthesiologists. This assessment of excess risk was based on small numbers (5 deaths observed vs 1.7 expected). Similarly there was a decreased mortality due to lung, mouth and esophageal cancers in part-time but not in full-time anesthesia specialists. The authors suggested that their positive findings may have emerged by chance from multiple comparisons.

All three studies failed to show any consistent increase in overall or cause-specific mortality due to exposure to anesthetic gases.

STUDIES OF REPRODUCTIVE OUTCOMES

The literature contains reports of studies which looked at outcomes of preganancies among wives of exposed males, and in those females directly exposed.

In 1967, a Russian study[69] found that in the female anesthesiologists studied, 18 out of 31 pregnancies ended in spontaneous abortion, two births were premature, and there was one congenital malformation.

In 1970, a Danish study[70] reported a higher incidence of both spontaneous abortion (20.4% vs 9.9%), and premature delivery (6.4% vs 1.4%) for pregnancies occurring after work exposure to anaesthetics compared to the employment period prior to, in nurse-anesthetists and anesthesiologists (or if male, that of their wives). There was no significant difference in the frequency of congenital malformations in children born before and after employment (1.0% vs. 0.4%). It has to be noted however that other possible confounding factors were not controlled in this study. The risk of abnormalities is known to be affected by maternal age at birth, and both increasing age and previous history of abortion seem to be factors related to increased spontaneous abortion rates. Low response rates and self reported outcomes raise questions of response bias and recall bias.

In 1971, a report of two studies conducted concurrently between 1965 and 1970 was published[71]; one compared female operating room nurses with female general duty nurses, and the other compared female anesthesiologists with female physicians in specialities other than anesthesia. The survey of nurses was conducted by personal interviews of 159 women, while the survey of 131 female physicians was conducted by mailed questionnaires.

Again, the outcome of interest in both these studies was abortion. The investigators collected data on health habits such as smoking, drinking and physical activity, use of contraceptive methods, gynecologic history, work history, maternal age at delivery and hereditary factors. This permitted the investigators to account for many of the potential confounding variables. The reported frequency of abortion in exposed and unexposed nurses was 29;7% and 8.6% respectively, with comparable figures of 37.8% among female anesthetists and 10.3% among female general physicians. It is possible that the results were affected by the small sample size and by recall or response bias. Moreover, the authors pointed out that an alternative explanation may be factors in the operating room other than trace anesthetics, such as stresses inherent in the employment, or the use of aerosol sprays to account for the higher rates of abortions observed among operating room personnel.

In another study conducted in the United Kingdom[72] a mail survey of 1391 female physicians showed more spontaneous abortions, congenital malformations and infertility occurring in anesthesiologists than among other physicians. A second comparison of anesthesiologists who were and were not working during pregnancy revealed a higher frequency of spontaneous abortion in the former (18.2%) than in non-working anesthesiologists (13.7%) and other physicians(14.7%), but only the latter difference was statistically significant. Anesthesiologists working during pregnancy reported a significantly higher frequency of congenital abnormalities among offspring (6.5%) compared with non-working anesthesiologists (2.5%), but this was not so with other physicians (4.9%). Infertility, defined as involuntary infertility of more than two

years' duration, was twice as frequent in anesthesiologists compared with the control group. Important factors that were not addressed in the questionnaire included age at each pregnancy, occupational speciality of control subjects, and the work history in relation to the obstetric history.

In 1975, the same investigators[73] conducted a similar survey among 5,569 male doctors, examining the frequency of spontaneous abortions, congenital abnormalities and infertility in the wives of physicians who worked in the operating room during the first trimester, compared with that among wives of doctors who had no regular operatng room exposure. Some of these women were also exposed to anesthetic gases themselves during the first trimester, and rates among them were calculated separately. Paternal exposure to anesthetic gases, as defined, appeared to have no effect on the frequency of either spontaneous abortions (11.1% exposed vs. 10.9% non-exposed), major congenital abnormalities (1.08% vs 1.05%) or involuntary infertility (9.7% vs 10.8%). This study included more extensive information than the earlier study such as information on occupation and obstetric histories. Age, however, remained uncontrolled, and the authors noted that men working in operating rooms would most likely be aware of possible health hazards related to their work and may have reported abnormalities more frequently than men in the control group.

In 1973, a Finnish Study[74] compared miscarriages and complications of pregnancy in 300 women working as anesthesia nurses, scrub nurses, casualty

and intensive care nurses, using a mailed quentionnaire between 1965 and 1973. In addition, the frequency of the outcomes during employment were compared with the frequency prior to employmemt. Miscarriages were most frequent among scrub nurses, with a very similar incidence in anesthetic nurses and those working in intensive care units. This led the authors to conclude that the findings may have been due to the effects of stress rather than to anesthetic exposure, but they did not measure stress directly. The study population was really too small to detect a small or even moderate hazard.

In 1979, a Swedish Study[75] examined the duration of pregnancy, perinatal death, birth weight and congenital malformations in 541 women who delivered during 1973 or 1975, as identified from birth records and from hospital employment records. All the women working in operating rooms during pregnancy were compared with all the women employed in other medical work. There was no significant differences in frequency between exposed and unexposed, for either perinatal death or congenital malformation. It was not possible to obtain information on spontaneous abortions.

In 1977, an English study[76], reported on the outcome of pregnancy among women physicians in England and Wales in 1975 who had been registered in 1950 or since. The 3,389 women who had at some time been pregnant reported a total of 9,301 conceptions. There were no statistically significant differences between anesthesiologists and other physicians for either spontaneous abortion or still births, but women who conceived while in anesthetic practice had significantly smaller babies and had children

with more congenital malformations of the cardiovascular system than other physicians. This study adjusted for cigarette smoking as well as age at pregnancy. No information was obtained on the length of exposure to anesthetics or whether the women were actually working during pregnancy.

In 1975, the ASA Ad Hoc Committee on the Health of Operating Room Personnel mailed questionnaires to over 73,000 members of professional societies for operating room personnel and the response was as follows: The ASA itself (7,617 replies), The American Association of Nurses Anesthetists (AANA) (9,030 replies), and the Association of Operation Room Nurses and Operating Room technicians (AORN/T) (13,163 replies). Questionnaires were also sent to members of the American Academy of Pediatrics (AAP) (3,532 replies), and the American Nurses Association (ANA) (6,702 replies) which served as control groups. The questionnaires were not designed to examine reproductive hazards exclusively, however questions included reproductive end points such as spontaneous abortions and congenital abnormality. Detailed information was obtained about occupational history and exposure to anesthetic gases, smoking, Rubella and X-ray exposure during each pregnancy, and the pregnancy history. Women in the exposed group reported significantly increased frequencies of spontaneous abortion and congenital abnormalities. In addition there was a significantly higher frequency of congenital malformations among children to both the wives of male nurses and technicians. A serious concern in this study design was the choice of the American Academy of Pediatrics as a control group, since from mortality experience the two groups differ

with respect to important, unidentified factors such as personality type or occupational stress, which may be confounders. Also, the study provided inconsistent findings e.g. the group with the least exposure to trace anesthetic gases (AORN/T) had the higest abortion rate, and congenital abnormalities among children of female nurse anesthetists were more frequent than among children of female anesthesiologists, although the latter group were probably more heavily exposed.

The same questionnaire was used by other investigators[77] to survey 3,593 men who were members of either The American Society of Oral Surgeons or the American Dental Associaton. In this study, exposure to anesthetic gases was defined as exposure for more than three hours per week, and the control group consisted of those dentists not exposed to anesthetic gases for this minimum period. There was a significant increase in the frequency of spontaneous abortion among the wives of exposed dentists (16.0 vs 9.0%), but the difference in the malformation rate was fairly small and insignificant. The only weakness in this study was that the response rate from the exposed was higher than the unexposed, suggesting response bias and recall bias. The questionnaire clearly stated its aim to assess health effects of waste anesthetics, hence making the occurrence of such bias more likely.

In a follow-up study[78], the same investigators conducted a mail survey of 21,634 male dentists and 21,202 female chairside assistants. An increased frequency of spontaneous abortions was found

among the wives of both lightly exposed and heavily exposed male dentists compared with that among wives of non-exposed men. Among female chairside assistants, there was a statistically significant increase in spontaneous abortions among both light and heavy anesthetic users compared with non-users. This study used ideal comparison groups(non-exposed members of the same professions), ascertained exposure directly, and controlled for confounding variables including age, cigarette smoking and pregnancy history. The response rate was 70%. Since dentists working in offices generally use exclusively nitrous oxide, one can attribute these reported reproductive outcomes to this single anesthetic.

STUDIES ON CHRONIC HEALTH EFFECTS

In the literature some studies examined the possible association between exposure to anesthetics and a number of chronic diseases including cancers, hepatic and kidney diseases.

The ASA study, showed increased rates of cancer, among both exposed female physicians and exposed female nurses, though only the latter association was statistically significant. The prevalence of hepatic disease was also greater in both exposed groups: 4.9% vs 2.9% (P=0.04) among physicians, and 3.8% vs 1.7% (p=0.01) among wives. The prevalence of renal disease was also greater in both nurses and operating room technicians, but not between exposed and non-exposed physicians.

Dentists experienced a significant difference in liver disease (5.9% vs 2.3%), but not for cancer or kidney disease[77]. They also had

an increase in neurological disease (2.4% vs 1.9%) as well as a significant increase (0.63% vs 0.35%) in non-specific neurological problems such as numbness, tingling and muscle weakness[78]. Among heavily exposed male dentists and chairside assistants, however, there were significant differences in reported liver disease,all kidney disease (renal stones in men), all neurological diseases and non-specific neurological disorders. No differences were found for cancer in these groups.

The cancer incidence among 525 female nurse anesthetists in Michigan was examined[79], comparing the observed age-standardized rate of malignancies with an expected age-standardized rate derived from Connecticut Tumor Registry data. Information about the incidence of any malignancy was collected by mailed questionnaire. The response rate was 84.5%, and analysis of the data showed an increased incidence of cancer, however the numbers of both participants and malignancies were too small to justify a positive result. The investigators furthermore did not verify reported diagnoses by examining the medical records.

CONCLUSION - HEALTH EFFECTS

From the results of the health effects studies, there is reasonably consistent evidence only for the adverse reproductive outcomes for women directly exposed to anesthetic gases during pregnancy. For non-reproductive outcomes, the data are much less consistent.

Summary relative risks (RRs) for each outcome under investigation have been calculated using previous studies published reports[80]. For each summary RR, they also calculated 95% confidence limits; when the range of the confidence interval excludes 1.0, the increased risk is statistically significant at the 0.05 level. The most consistent evidence was for spontaneous abortions among pregnant physicians and nurses who work in operating rooms, where the RR was 1.3 (95% confidence limits from 1.2 to 1.4). For liver disease there were statistically significant increased RRs among both men (1.6, 1.3-1.9) and women (1.5, 1.2-1.9), but these were based on a smaller number of studies. Although the results of pooled analyses are suggestive, most studies of this issue have relied on voluntary responses and self reported outcomes, so that response and/or recall bias could explain these findings. In addition, as the authors note, the investigations generally have correlated adverse health effects with subjects working in operating rooms, rather than the actual exposure to anesthetic gases.

LITERATURE REVIEW - HYGIENE ASPECTS

INTRODUCTION

Anesthetic gas exposure to personnel in the operating room is due to waste anesthetic gas from specific emission sources such as the ventilator and exhalation value during the delivery of anesthetics to patients, and to leaks in the anesthetic equipment. A number of factors affect control of waste anesthetic gas concentrations in the operating rooms and these include: dilution ventilation, local exhaust (scavenging), work practices, the extent of leakage and the maintenance of equipment.

Equipment

Anesthesia machines[1,2] deliver accurately measured concentrations of N_2O (nitrous oxide), oxygen and vapours such as halothane, enflurane and isoflurane by the use of flow meter valves. The halogenated agents are introduced into the circuit by bubbling oxygen(O_2) through their volatile liquids which are contained in a vapourizer chamber. Each machine consists of a high pressure system from the source of gas delivery to the flow meter control valves (where the pressure is reduced), and a low pressure system beyond which includes the breathing circuit.

N_2O and O_2 are normally supplied via pipelines through the wall or ceiling at working pressures of 50 to 55 pounds per square inch (psi) and leakage may occur at the connection between the flexible hose and

the machine's inlet connections. Within the machine, gas leaks may occur up to the flowmeter control valves, but are minimized beyond this point because the N_2O and O_2 pressures are reduced, although still above atmosphere.

There are four major categories of breathing systems - closed, semi-closed, semi-open and open.

Low pressure leaks may occur at the connections between components but more commonly at the ventilator outlet and face mask or endotracheal tube outlets when the tube is uncuffed.

When the patient exhales the inhalation valve on the breathing circuit closes, causing a unidirectional flow of expired gases (including excess anesthetic gases) to the exhalation valve. This is an additional source of room contamination. It is common practice today for the exhalation valve to be connected to a scavenging device that disposes of the gases through a vacuum line to a ventilation system. In other cases the scavenged gas is removed by tube to a convenient room exhaust grille.

The scavenging device connection to the vacuum line requires a pressure balancing system to prevent the pressure from affecting the flow in the breathing circuit. This safety precaution is provided by an interfacing system.

Exposure Control Methods

1. Ventilation

a) Dilution

i) American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Guideline and Rationale

The ASHRAE Handbook[3] provides in a concise table the ventilation requirements for 40 different types of rooms varying from operating and recovery rooms to equipment storage facilities.

The guideline refers to two basic systems, non-recirculating and recirculating. For the former, a minimum of 15 air changes per hour (AC/hr.) is required and for the latter a total of 25 AC/hr. of which 20% shall be outside air. In addition, operating rooms should use 100% outside air in those cases where local codes require it, and where heat recovery devices are utilized. Recirculated room air shall pass through HEPA (high efficiency particulate aerosol) filters when indicated.

The ASHRAE guidelines appear to be designed more for bacterial contamination control than anesthetic waste gases. This is illustrated by the fact that there are specific details for the number and efficiency of filter beds required, but little or no information on the control of anesthetic gases. The discussion of anesthetic gases is limited to the following statement:

"A small amount of exhaust air may be considered for removal at the ceiling above the operating table to eliminate collection of anaesthetic gases and to minimize operating light heat buildup".

The ASHRAE guidelines have been reviewed by Luciano[4]. Prior to February 1969, at which time the codes were revised, the air conditioning systems for operating suites required 100 percent outside air. The reason for this was to minimize the risk from explosive anesthetic gases and the buildup of bacteria. As the technology of anesthesiology advanced, the level of explosive gases into the operating room atmosphere was reduced to low levels and, concurrently, the development and introduction of filtration systems reduced airborne bacterial levels.

According to ASHRAE, if the air exchange rate is less than 25 AC/hr. recirculation is not permitted during the use of the operating room. However, a request for a variation from this position for renovation work in the operating suite of a hospital located in Maryland was granted by the Department of Health and Mental Hygiene[4]. The variance was granted upon the following conditions:

- The supply air system controls shall be interlocked such that whenever any O.R. surgical light is on, the system will revert to 100% outside air, and the reverse will occur when all O.R. surgical lights are off.

- A dedicated anesthetic gas scavenger system will be employed.

- The decision to allow constant recirculation rests upon the evaluation of data relative to anesthetic gas levels collected by independent testing consultants.

In other words, if it can be demonstrated that recirculation does not raise the concentration of waste anesthetic gas in the O.R., recirculation is permitted.

ii) Literature Review of Measurements of AC/hr in OR's

While scavenging systems comprise local exhaust ventilation, the number of air changes per hour determines the dilution ventilation and is used in that sense in the literature describing hospital or specifically operating room ventilation. This control measure was not explored fully in the literature since it does not constitute an independent control measure.

The minimum air exchange rate quoted by the U.S. Department of Health, Education and Welfare[5] is similiar to the ASHRAE guideline in that it is 25 air changes per hour of which only 5 air changes/hour are fresh outside air. Where the system is a non-recirculating system (100% fresh supply) the number of air changes for operating rooms is reduced from 25 to 15.

The British Columbia government committee on surgical suite ventilation, in its July 1975 report, as quoted by Oulton[6], recommended 20 air changes per hour of which 15 air changes per hour would be fresh outside air. Ventilation assessments in the

Vancouver General Hospital showed that the air was not recirculated but changed 12 to 15 times per hour[6]. This hospital would be marginally below the British Columbia government's recommendation.

In Alberta, a hospital was studied[7] and it was found that the total air supply met the design criteria of 15 air changes/hour but the amount of air recirculated was more than the quantity allowed. No details were given in the report on how many air changes/hr. were recirculated.

In Ontario, a study report on a Northwestern General Hospital[8] operating room was found to have 18 air changes per hour with no indication if any of the air was recirculated.

Concentrations of halothane anaesthetic vapours were measured in the operating rooms of two hospitals in Ottawa[9]. In the first hospital all the operating rooms were air conditioned with non-recirculating systems capable of providing total air exchange rates of 16 to 20 per hour. In the second hospital three air conditioning systems supplying 100% outside air were installed for the six operating rooms. In one of the rooms there was a recirculating control which allowed flexible adjustment from 100% outside air to 100% recirculated air, but no recirculated air was ever used. In this second hospital the average air change rate was 15 with a range of 13 to 17 air changes/hr. The halothane readings in both hospitals were well below 500 parts per billion (ppb).

In France[10], regulations call for a minimum of six air changes per hour of outside air (minimum of 30 cfm/person of outside air) of a total of 15 air changes/hr.

The Ontario Ministry of Health has a requirement that a major operating room must have a minimum total air supply of 24 air changes/hr. and there must be no recirculation during normal working hours. When the room is not occupied it is permissible to recirculate 16 of the 24 air changes/hr.

From the preceding it can be concluded that the minimum air exchange rate for non-recirculating systems is 15 air changes/hr. in the U.S. and 24 air changes/hr. in Ontario. It is difficult to say that above 24 air changes/hr. the exposure is better controlled. It is important to realize that high flow rates are costly and may cause drafts, and many people may feel uncomfortable at air exchange rates above 24/hour. Drafts can be reduced by the careful choice and location of the supply grille. Efficient diffusers, such as the aspirating and entrainment types, tend to mix the room air at uniform velocity thereby reducing drafts and localized high concentrations of anaesthetics.

Finally, it should be noted that the dilution ventilation was found to have an effect on sampling strategy.[11,12] In general, an operating room with 15 or more air changes per hour will have few "hot spots" (pockets of high concentrations) and sampling at the exhaust grilles will be quite satisfactory. If the operating room has fewer than 15

air changes per hour there may be consistent "hot spots" and readings at these locations as well as at the exhaust grilles should be taken and recorded.

iii) Effect of Recirculation on Air Levels

As mentioned earlier two basic types of air supply are reported to be used in operating rooms. A non-recirculating type and a recirculating type. A non-recirculating system is ideal for anesthetic gas disposal, however, it has the disadvantage that all of the air must be heated or cooled (which can be very costly). This is why the recirculating system is employed by many hospitals.

In a recirculating system air exhausted from a room is filtered through HEPA filters for bacterial decontamination and is then recirculated through several rooms by means of a common mixing chamber (plenum). In this process some fresh air is added and an equal amount of recirculating air is exhausted. HEPA filtering does not remove anaesthetic gases; accordingly recirculating systems have to be supplemented by an efficient scavenging system[13].

According to the Canadian Standards Association (CSA)[12] it has become a common practice to provide for night-time recirculation of the air for the operating and delivery rooms proper. CSA approves the use of recirculation of exhaust air in the ventilation system at night for energy conservation provided that 100% non-recirculation occurs during room use.

iv) Floor Exhaust

Some researchers have suggested that N_2O and Halothane would settle at floor level being heavier than air and a floor exhaust ventilation would be the preferred method for removal. However this was considered highly controversial.[14]

Exhausting anaesthetic gases at floor level was evaluated by NIOSH[13] and the results indicated that venting anaesthetic gases at the floor level produced slight, if any, reduction in exposure of personnel. This is in agreement with standard industrial ventilation design practice[15] which states that gas and vapours with higher density than air in health hazard concentrations are not appreciably heavier than air.

ASHRAE[3] recommends floor exhaust in ultraclean areas (not necessarily ORs) to provide a downward movement of clean air through the breathing and working zones to the contaminated floor area for exhaust.

v) Laminar Flow

A study by Caknes[28] suggests that a ceiling mounted air discharge unit which provides a laminar flow environment makes the use of scavenging unnecessary. This was found only if the air change rate is greater than 50 AC/hr.; otherwise air is introduced in a turbulent flow manner.[29]

In contrast other studies[20] found that laminar flow air conditioning was insufficient in itself to maintain acceptably low nitrous oxide concentrations without the use of scavenging.

b) Local Exhaust (Scavenging)

Scavenging is defined[13] as the collecting of waste anesthetic gases and vapours from the patients anesthetic breathing systems at the site of overflow and the disposal of them. The purpose of such scavenging systems is to control waste gases at the source, similar to local exhaust in an industrial operation.

A study in Alberta[7] showed that relying upon general room ventilation alone (dilution effect) was not a suitable method for controlling environmental contamination. The nitrous oxide concentrations with no scavenging were found to vary from 93 to 206 ppm.

The results of a study by McCutcheon[8] in a Toronto Hospital demonstrated that when the scavenger system was not being used, the concentration of nitrous oxide could go as high as 1,325 ppm,while the concentration of nitrous oxide could be maintained in all areas of the operating room below 25 ppm with a properly functioning scavenger system.

In unscavenged operating rooms, halothane levels as high as 2,500 ppm were measured in the vicinity of the expiratory valve[23]. This high concentration is more correctly referred to as a leak source sample, and a representative figure for a personal breathing zone sample in the operating room was 10 ppm.[24] As these studies were based on "spot checks" their readings may give misleading information about the average exposure of personnel.

Scavenging alone was reported[16] to reduce anaesthetic contamination in the operation room by tenfold. However, based on information considered from other studies, this would seem a very conservative estimate.

Two NIOSH Health Hazard Evaluation investigations [25,26] reported environmental surveys of operating rooms and recovery rooms in two hospitals that were not using waste gas scavenging. In the first hospital[25] nitrous oxide concentrations in the operating room ranged from 5 to 6,000 ppm with a median of 525 ppm. Halothane concentrations ranged from 0 to 21.3 ppm with an average of approximately 3.5 ppm. In the second hospital[26] nitrous oxide concentrations in the general operating rooms ranged from 150 to 3,000 ppm with a median of 430 ppm. Halothane concentrations in the general operating room ranged from 0.3 to 7.0 ppm.

The NIOSH Criteria Document[17] provides a detailed summary of typical concentrations without anesthetic gas scavenging. This data reports one personal exposure of an anesthetist as high as 6,000 ppm N_2O. While the remaining results are 1,000 ppm or less, they are all above 100 ppm.

The value of scavenging systems has been demonstrated by NIOSH Studies.[17] Tables 1-3 show the effect of scavenging on the airborne concentrations of anaesthetic gases in ORs.

TABLE 1

SUMMARY OF ANAESTHETIC GAS CONCENTRATIONS IN LOCATIONS WITH WASTE GAS SCAVENGING (from ref. 17)

Gases Sampled	Sampling Site	Concentration Mean, ppm	Waste Gas Control Method
Halothane	Anaesthetist, OR	0.79	Scavenging to wall suction
"	"	0.73	"
Nitrous oxide	Anaesthetist, OR	135	"
Halothane	"	0.85	"
Nitrous oxide	"	24	Scavenging to air conditioning exhaust grille
Halothane	"	1-2	Scavenging to wall suction
Nitrous oxide	General air, OR	35	Not given
Halothane	"	0.24	"
Enflurane	"	0.9	"
Halothane	Anaesthetist, OR	0.2	Venting to pipe in floor plus 10 room air changes/hr
Nitrous oxide	General air, OR	15	Scavenging to air-conditioning exhaust grille, all leaks in machine repaired
"	Anaesthetist, OR	18	
"	Surgeon, OR	17	
"	Scrubnurses, OR	13	
"	Circulating nurse, OR	14	
"	Dentist, DO	14	Double suction mask, mouth hook, and fan
"	Anaesthetist, DO	7	
"	General air, DO	13	

OR - Operating Room
DO - Dental Office

TABLE 2

CONCENTRATIONS OF NITROUS OXIDE IN ROOM AIR DURING ANAESTHESIA WITH SCAVENGING (from ref. 17)

Anaesthetic Technique	No. of Syringe Samples	Average Concentration of N_2O (ppm)
Mask	75	36 ± 6.7*
Endotracheal tube	76	15 ± 2.4
Endotracheal tube with ventilator	57	34 ± 7.8
All samples	208	28 ± 3.4

*Standard Error

TABLE 3

COMPARISON OF NITROUS OXIDE CONCENTRATIONS BY SAMPLE SITE WITH SCAVENGING IN USE (from ref. 17)

	N_2O Concentrations ppm ± S.E.*
Exhaust Grille	15 ± 2.7
Anaesthetist Breathing Zone	18 ± 2.9
Surgeon's Breathing Zone	17 ± 5.0
Scrub Nurse	13 ± 3.2
Circulating Nurse	14 ± 2.8
Door	14 ± 2.8

*Standard Error

A scavenging system consists of three major components:

- A waste anaesthetic gas collector which is either attached to the exhalation valve or the ventilator.

- A suction tubing system to carry waste gases from the collector to the wall or ceiling exhaust ventilator.

- A vacuum interfacing unit which relieves positive pressure in the event of scavenging system occlusion and prevents pressures from reaching the patient circuit when a fan or central exhaust system is used.

A well-functioning scavenging system is essential because excess gases escape from the anesthesia breathing circuit via the exhalation valve at a rate of 0.5 to 5 litres/minute, depending on the work practices of the anesthesiologist.[18]

All manufacturers of anesthetic machines and anesthetic ventilators provide scavenging type expiratory valves on new equipment sold in Canada today.[11] There are scavenger adaptor kits for virtually all anesthetic machines and anesthetic ventilators except for very old machines.

An effective scavenging system should not present a hazard to the safety of the patient by the application of excess negative or positive pressure to the anesthesia breathing circuit.

If the disposal system presents a negative pressure of 5 mm Hg or less, balancing can be achieved by the usual adjustment of the scavenging pop-off valve. Non-rebreathing systems, which are particularly sensitive to slight negative pressure balancing, require special attention. The bag outlets and the inhalation valve are connected so that waste anaesthetic gases from the non-rebreathing valve are introduced into the exhalation valve and passed through the pop-off valve to the disposal system. Proper bag inflation is maintained by adjustment of the circle pop-off valve. Negative pressure greater than 5 mm Hg should be reduced using interfacing equipment for additional pressure equalization.

There are various effective methods of collecting waste anesthetic gases which are described in the literature [13,18] and are illustrated as follows:

Figure 1 shows a scavenging trap installed on the exhalation valve of the circle absorber.

Figure 2 shows a non-rebreathing system, where fresh anesthetic gases enter at the breathing bag and all excess gases leave through the scavenging system.

Figure 3 shows a T-tube system which has a clamp that permits adjustment of gas outflow to maintain proper bag filling with a plastic tube inserted to prevent accidental occlusion of the tail of the bag.

Figure 4 shows a scavenging exhaust with the ventilator and gas machine interconnected. The need to join these systems to the vacuum line with a Y connection is because many anesthesiologists switch back and forth between spontaneous and controlled breathing.

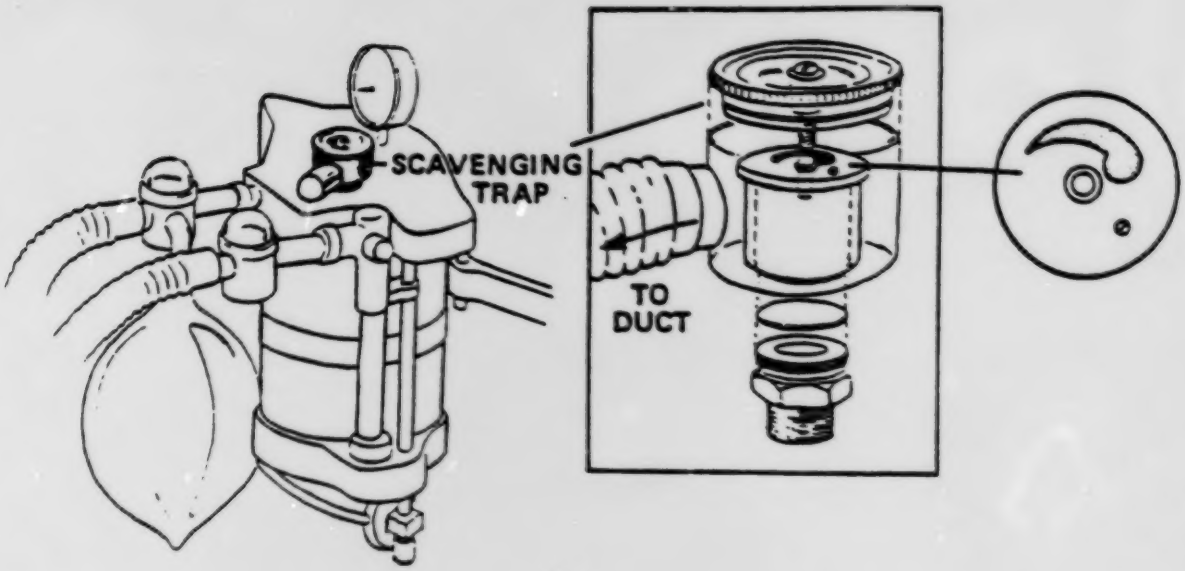

Figure 1. Dupaco Scavenging Pop-off Valve for Circle Absorber (from ref. 1-1)

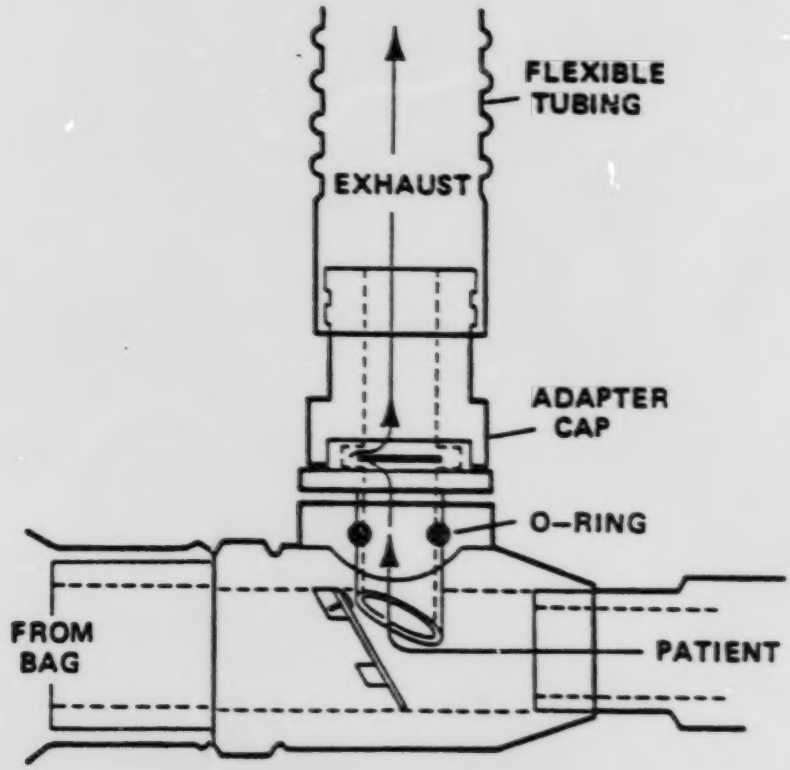

Figure 2. Waste Gas Collector for Dupaco Nonrebreathing Valve (from ref. 1-1)
Effluent gases are captured by adapted cap.

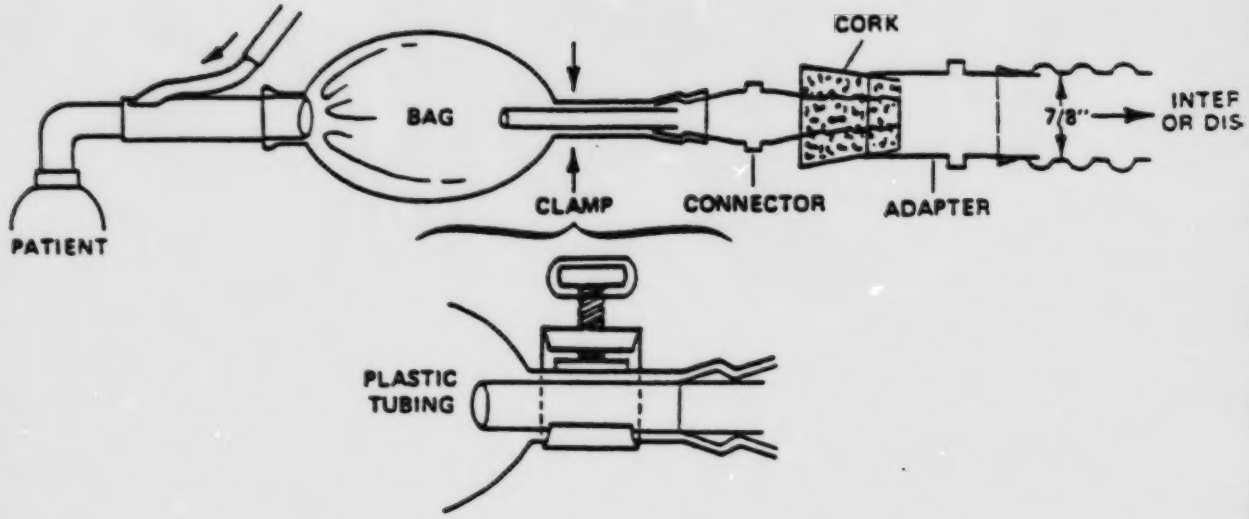

Figure 3. Waste Gas Collector for T-Tube (from ref. 14)
Effluent gases are captured at tail of bag.

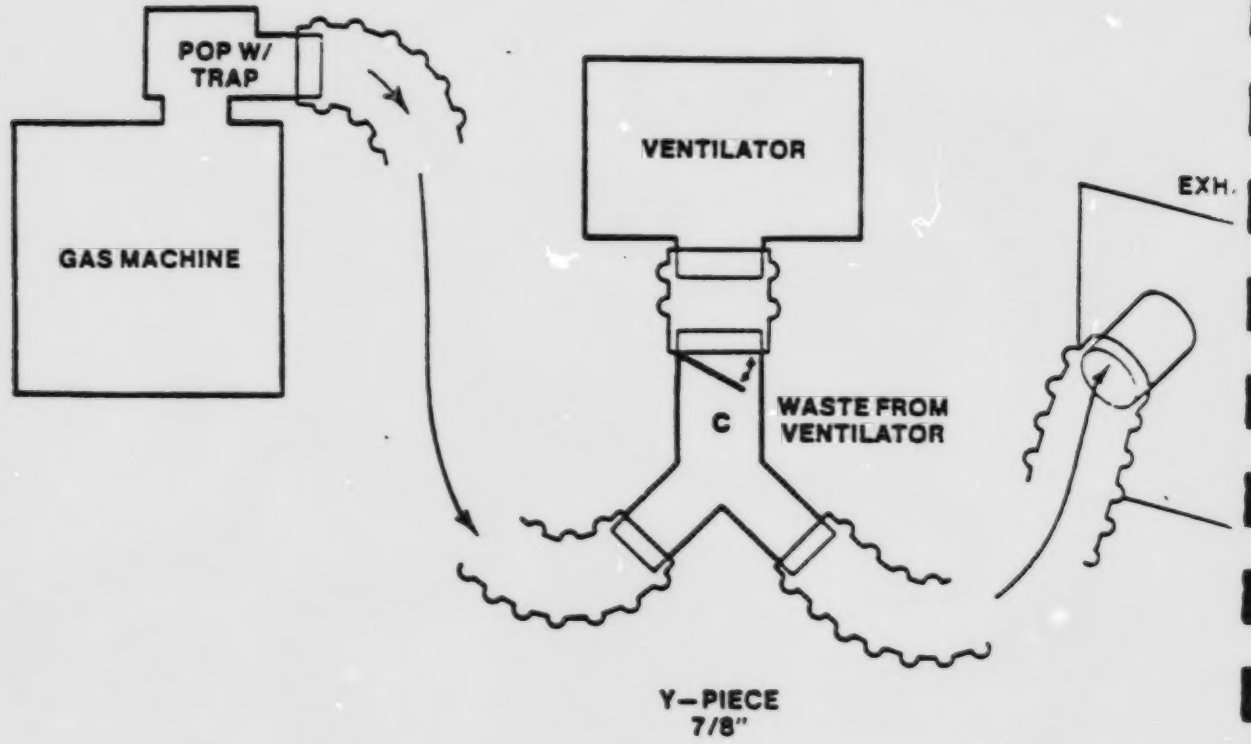

Figure 4. Use of a Y-Piece to Collect Waste Gas from Absorber, Ventilator, and Check Valve (C) to Prevent Leakage (from ref. 14)

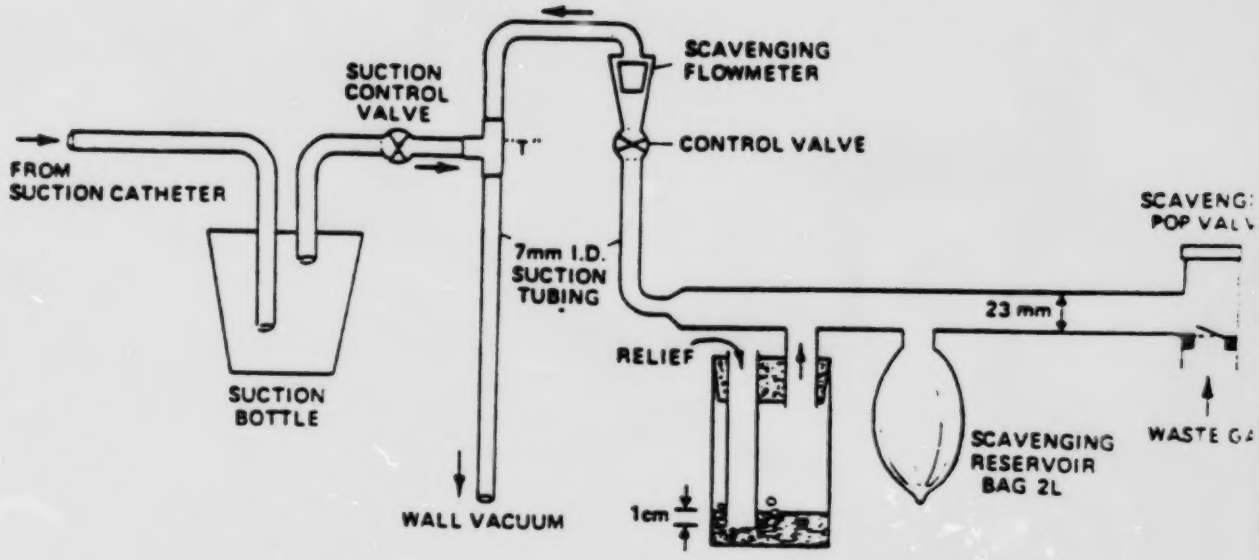

Figure 5 Vacuum Interface Assembly for Disposal into Wall Suction (One Outlet) (from ref. 19)

2. Maintenance and Work Procedures

i) Anesthetist Working Procedures

The manner in which anesthetics are administered (work procedures) can contribute significantly to trace gas levels in the operating room. A NIOSH study[13] has estimated that work practices of the anesthetist may contribute from 94 to 99% of all waste anesthetic gases in an operating room equipped with properly designed scavenging components. NIOSH identified some of the work practices that lead to high levels of waste gases and the manner by which it could be avoided without compromising patient safety as recommended by the American Society of Anesthesiologists[16].

Trace gas contamination resulting from work practices tends to be transient, but can reach quite high levels and in the case of a loosely fitted face mask, such levels can persist throughout an operation. Other improper practices such as scavenging tubes not properly connected, cuffs on the endotracheal tube leaking, and spillage of volatile anaesthetic agents when filling vaporizers are the chief contributors.

The mode of administration of the anesthetics to the patient (intubation or face mask) is decided by the anesthetist. In general, lower waste gas levels are noted with tubes than masks. Documentation by NIOSH studies[13] placed a figure of approximately 50% waste reduction when comparing the two procedures.

The following is a list of work practices suggested in the literature[8,13,16,17,18] to reduce gas leakage:

a) Before starting an anesthetic, check to see that the scavenger is connected to an operating suction or other disposal route.

b) Select a face mask that will ensure a tight fit with minimal pressure. This is very critical. Often very small changes in mask angle can mean the difference between a poor and a tight fit.

c) Vapourizers should be filled in a ventilated area and in a manner to minimize spillage of the liquid agent. It is interesting to note that a few drops of anesthetic liquid can produce 200 cc's of anaesthetic vapour. To avoid spillage a funnel can be used for filling, and a tissue wrapped around the bottle, to be discarded after, is an effective way of collecting spilled material. Where feasible the vapourizer should be recharged at the end of the day so that any small amounts that are spilled will be vapourized and the vapour cleared from the room long before the operating starts the next day.

d) The vapourizer should be turned off when not in use.

e) Unless warranted by the clinical situation, avoid turning on the N_2O or volatile agent until the mask is properly fitted, or the trachea is intubated and the endotracheal tube is connected to the circuit. By doing this, excess gas does not leak unnecessarily into the operating room and contamination is minimized.

f) When the breathing circuit is disconnected from the patient after administration of the anesthetic agent has started, anesthetic flow meters should be turned off or the Y-piece sealed.

g) If it is necessary to empty the breathing bag, empty it into the scavenging system without disconnecting it from the absorber or patient.

h) At the end of an operation, before removal of the endotracheal tube or mask, administer 100% oxygen for as long as possible, so that the washed out anesthetic gas can be removed by the scavenging system. As well as benefiting the patient, this keeps contamination to a minimum.

In addition, the following common sense work practice recommendations assisted one Ontario Hospital[22] in reducing the nitrous oxide levels to which staff were exposed:

- An attempt should be made to locate the anesthetic machine as close as possible to one of the room's active exhaust openings. This will help minimize exposure of the surgeon, scrub and circulating nurses to those gases and vapours escaping from the machine.

- Staff should be alerted to the importance of not obstructing floor exhaust openings in the operating rooms. Any partial obstruction by laundry carts, etc., reduces the efficiency of the exhaust system almost in direct proportion to the surface area which is obstructed.

ii) Maintenance of Anaesthetic Equipment

It has been documented in the literature[19] that adherence to proper work procedures would never in themselves be enough to control operating room waste gas contamination if the maintenance of anesthetic equipment is poor.

In a study by the American Hospital Association[18] low pressure leakage was identified in three problem areas:

1) hose leakage at the following sites:
    a) ventilator bag connection
    b) Y-connectors
    c) tubing connections
    d) gas delivery lines
    e) improper insertion of bypass tubes
    f) tube deterioration

2) leakage during cleaning or clean-up techniques caused by:
    a) bad dome seals
    b) bad canister seals
    c) open petcocks

3) leakage due to poor design or improper installation.

In this survey, many of the exhalation valves were not designed to be gastight, and some ventilators with a scavenging port had a higher N_2O flow rate from the opening facing the anesthetist than from the scavenging port to the disposal system. Incorrect installation was found in 8 of 29 surveyed ventilators.

The following is a further list of leak sources[19,23,25,26]:

i) face mask or endotracheal tube
ii) bad connections in the breathing circuit
iii) pin holes in tubes and bags
iv) leaks in the high pressure circuits
v) leaks from the vapourizer
vi) escape during patient recovery
vii) gaskets might be missing
viii) tapered fittings deformed
ix) leaks from flow meter connections

Inspection and maintenance should be regular and include:

- leak testing of high and low pressure components; and

- inspection of face masks, tubing, breathing bags, and endotracheal tubes for cracks and signs of deterioration.

Specific details on recommended leak test methods are available in the literature[13,17,21].

It is therefore imperative that a leakage testing programme be an essential part of the control strategy in an operating room for both the high and low pressure sides. As a general rule, all equipment should be tested for leakage and retested at least every four months. The low pressure piping and equipment provided with slip-over connections should be checked weekly for leakage.

The effects of leaks on room concentration has been well documented in the literature. In a report by the Ontario Ministry of Health[11] it was stated that a single pin hole in tubing or a slightly deformed metal to metal joint can leak enough to raise the level of nitrous oxide in the operating room by 5 to 10 ppm. When cylinders were not properly sealed with tightened fittings, nitrous oxide levels were found to be greater than 50 ppm in a passive ventilated supply room enclosure[19].

Anesthetic machines and their scavenging systems should routinely undergo servicing at regular intervals by a manufacturer's representative or equivalent. Both high and low pressure portions of the anesthesia machine should be examined and leakage corrected. It is to be noted, however, that these routine service visits do not always identify or correct all of the high or low pressure leak points. In fact, significant leakage may remain after routine servicing. Additionally, leakage can develop suddenly especially in a low pressure system[20]. In-house regular monitoring by department personnel is necessary to ensure that leakage is minimized at all times.

Disposal of Waste Gases

Waste anesthetic gases, collected at the anesthetic breathing machine, should be vented in such a manner that contamination of hospital intake air for other areas where personnel are working does not occur.

The literature is quite consistent in its description of the disposal methods which are available [11,12,13,17,18,27]. The following is a brief description of those methods.

1. Air Conditioning Exhaust Grille Method

If the operating room air conditioning is of the non-recirculating (one-phase) design, waste gases from the scavenging trap are vented directly to the room's air conditioning exhaust grille. While in some of the earlier designs the scavenging tube was terminated at the grille, this is not the preferred method since leakage into the operating room may occur in the presence of low air flow rates. The preferred method is to pipe the system to a plate secured to the exhaust grille. The pipe should go through the plate, well into the exhaust duct.

In recirculating air conditioning systems, waste gases are introduced into the exhaust duct by entering downstream from the point of recirculation.

2. Central Vacuum System

The room central suction system may be used as a waste gas disposal route provided sufficient flow capacity is available. If such a system is used, a vacuum break (pressure balancing system) should be located between the central vacuum suction outlet and the anaesthesia breathing circuit. This is to ensure that the unrestricted negative pressure cannot enter the anaesthetic breathing system and cause collapse of the patient's lungs.

3. Separate Vacuum System

A special vacuum system for waste gases separate from that used for medical suction may be used. Using this technique it is possible for waste gases from more than one operating room to be collected into a common duct leading to a main duct and then discharged to the roof.

4. High-Flow Low Vacuum

The basic distinguishing feature between this system and the central and seperate vacuum is that the other two systems have low-flow high vacuum characteristics. A high-flow, low vacuum dedicated exhaust system may be considered where there is no central vacuum or non-recirculating air conditioning system.

5. Direct Vent to Outside

In this case, the exhaust of the scavenger is simply vented to the outside without the use of any fan. This system has a number of severe limitations yet NIOSH[13] suggests that, despite its limitations, it may be considered ideal in older hospitals constructed with windows that are not able to be opened and in the absence of non-recirculating air conditioning.

6. Passive to Floor

Gases are vented to the floor and a halothane absorption system is used but it is not effective for N_2O disposal. Although suggested in two references, [18],[27], this is not recommended for it is based on a principle that is highly controversial (see floor exhaust).

In considering the various disposal routes, it is obvious that the various advantages and disadvantages must be considered in making an appropriate selection. A summary of this information is given in Table 4 as published by the American Hospital Association[18].

While the summary of advantages and disadvantages is useful information to aid in selection, the Canadian Standards Association[12] and the Ontario Ministry of Health[11] have suggested the following order of preference:

a) Removal by a non-recirculating exhaust system serving portions of the O.R. suite;
b) Removal by a separate low vacuum system designed for the service;
c) Removal by piping to an exhaust grille of a non-recirculating O.R. exhaust system;
d) Removal by a separate exhaust system designed for the service; and
e) Removal by means of the hospital vacuum system.

TABLE 4

ADVANTAGES AND DISADVANTAGES OF ALTERNATIVE DISPOSAL ROUTES
(from ref. 18)

Disposal Route	Advantages	Disadvantages
Air exhaust duct work	No new maintenance is required of gas machines or accessories.	Room geometry (hoses) may be so awkward that they are likely not to be connected or used.
	No extra burden is placed on motors.	Hoses may get crushed.
	No reservoir is needed.	Hose is potential site for bacterial growth.
	No interface (positive or negative presssure) device is needed in disposal route.	System requires non-recirculating air-conditioning with 100% exhaust air.
	Cost is minimal for potentially effective route.	System is not suitable for flammable gases without a non-sparking exhaust fan and system design.
Existing vacuum	Room geometry and hoses are similar to those already present.	Life of pumps may be shortened by burden, especially if not shut off in O.R. at end of day.
	It is easy to remember to connect the system because oxygen is usually obtained in similar fashion.	Flow limiters must be periodically cleaned of lint.
		System may have to share limited vacuum flow with requirements of the surgery.
Dedicated vacuum	Room geometry and hoses are similar to those already present.	System requires major renovation or installation or new construction at high cost.
	It is easy to remember to connect the system, because oxygen is usually obtained in similar fashion.	Extra maintenance and energy costs for additional pumps are needed.
	With high enough flows, system can be used for flammable gases.	Flow rate must be monitored to avoid occlusion of filters.
		Extra hose and special connectors are needed.

TABLE 2 (CONTINUED)

ADVANTAGES AND DISADVANTAGES OF ALTERNATIVE DISPOSAL ROUTES

Disposal Route	Advantages	Disadvantages
Dedicated (high-flow) exhaust	No new maintenance required of gas machine or accessories.	Initial cost is high.
	No reservoir is needed.	Extra maintenance costs for additional motor(s) are needed.
	No interface (positive or negative pressure) device is needed in disposal route.	Unique, nonstandard connections or components are needed.
	With high enough flow, system can be used for flammable gases.	System requires renovation or new construction.
	System can be brought to ceiling column.	
Passive to outside	Cost of relief valve and 10-15 feet of tubing is minimal.	Hose is potential site for bacterial growth and entry of outside air.
	No reservoir is needed.	Positive or negative interference may be required.
	No halothane adsorption device is needed.	Tube on outside is subject to winds and insects, which invade the operating room.
	System is effective with recirculating ventilation systems.	
	System is a good temporary method if medical vacuum system is overloaded and using recirculating ventilation system.	
Passive to floor	Cost of relief valve and 36 inches of tubing hanging to floor level is minimal.	Halothane adsorption unit is not effective for N_2O.
	Halothane adsorption device is simple.	System is not effective with recirculating ventilation systems.
		Room-air turnover and flow patterns are not generally sufficient to keep concentrations of N_2O below 25 ppm.

SUMMARY - HYGIENE ASPECTS

The minimum dilution ventilation suggested for operating rooms with recirculating air systems by ASHRAE in 1978 is 25 air changes per hour with only 5 changes/hour as fresh outside air. When the system is non-recirculating the total air requirement is reduced to 15 air changes/hour. This recommendation still stands.

Prior to 1969 there was a mandatory requirement in the United States for 100% outside air in operating rooms. This requirement was primarily due to concentration of explosive gases and the concentration of bacteria buildup due to organisms generated by people. With the development of the high efficiency particulate aerosol (HEPA) filter recirculation is now possible however it is important to realize that these filters, while efficient for bioaerosols, do not remove anaesthetic gases.

With leaks existing in the operating room, the effect of recirculation on the concentration of waste gases in the operating room concentration has been demonstrated. Given a constant leak rate and 25 air changes/hour, if 20 air changes/hour are recirculated, the concentration of anaesthetic gases is five times that of the concentration when there is no air recirculation.

It is now common practice in Canada to provide for night time recirculation of the air in operating and delivery rooms, with no recirculation during the operating period.

In Ontario, the Ministry of Health has a requirement that major operating rooms must have a minimum of 24 air changes/hour and there must be no recirculation during normal working hours. When the room is not occupied it is permissible to recirculate up to 16 air changes/hour.

In British Columbia a government committee on surgical suite ventilation recommended that 20 air changes/hr. be provided, of which 15 should be exhausted outdoors.

In France regulations call for a minimum of six air changes per hour of outside air (minimum of 30 cfm of outside air/person) within a total of 15 air changes/hour.

Because N_2O and halothane are heavier than air, it was suggested that these contaminants would settle at floor level and thus, floor exhaust ventilation would be the preferred method for removal. However, studies by NIOSH verified that air currents are the primary factor in the distribution of anesthetic gases in the operating room. This is in agreement with standard ventilation design which states that gas and vapours in health hazard concentrations are of the same density as air due to a very large proportion of air being present. However, floor exhaust may be used to improve the air movement pattern.

A study by Caknes suggested that a ceiling mounted air discharge unit which provides a laminar flow environment makes the use of scavenging unnecessary. In contrast to this opinion, Torda found that laminar flow alone was not sufficient to maintain acceptable nitrous oxide

concentrations. It is doubtful whether many hospitals would install laminar flow since experiments by Intag showed that flow rates greater than 50 AC/hour are needed to achieve laminar flow.

Scavenging is defined as the collecting of waste anesthetic gases and vapours from the patient's anesthetic breathing systems at the site of overflow, and the disposal of them. A well-functioning scavenging system is essential because excess gases escape from the anesthetic breathing circuit via the pop-off valve at a rate of 0.5 to 5 litres/minute depending on the work practices of the anesthesiologist.

All manufacturers of anaesthetic machines and anaesthetic ventilators provide scavenging type expiratory valves on new equipment in Canada today. There are scavenger adaptor kits for virtually all anaesthetic machines and anesthetic ventilators, except for very old machines.

Because many anesthesiologists switch back and forth between spontaneous and controlled breathing, it is necessary to provide simultaneous scavenging from both the pop-off valve and the ventilator. To satisfy this need ventilators now come equipped with a scavenging exhaust, with the ventilator and gas machine interconnected with a Y or T connection, to allow easy switching between the two locations.

A NIOSH study has estimated that work practices of the anesthetist may contribute from 94 to 99% of all waste anesthetic gases in an operating room equipped with properly designed scavenging components. A study by Kramer contradicted the NIOSH study by concluding that the

single most important factor causing gas contamination was inadequate preventive maintenance of anaesthetic equipment.

It is important to stress that scavenging can cope only with the release from the expiratory valve in the anaesthetic circuit or similar valve located in the ventilator. There are, however, nine other common leak sources which are not scavenged. The literature clearly illustrates the effects of leaks on room concentrations. A single pin hole in the tubing can raise the level of nitrous oxide in the operating room 5 to 10 ppm.

A high and low pressure leakage testing program should be an essential part of the control strategy. As a general rule, equipment should be tested every four months. Low pressure piping and equipment provided with slip-over connections should be tested weekly for leakage.

While equipment leak prevention is very important, the literature clearly shows that where there is no scavenging system the concentration of waste anesthetic gas will be excessive. Data from the NIOSH Criteria Document reports typical concentrations without scavenging. These data report one personal exposure of an anesthetist as high as 6,000 ppm N_2O. While the remaining results are 1,000 or less, they are all above 100 ppm.

The Canadian Standards Association and the Ontario Ministry of Health have suggested that the preferred waste disposal method is removal by a non-recirculating system serving portions of the O.R. suite.

METHODS

The hospital selection and study design were jointly reviewed and agreed upon with the Ontario Hospital Association:

A. Selection of Sample of Hospitals and Population to Be Surveyed

A representative sample of hospitals was selected to be surveyed by the Industrial Hyienist, i.e. 74 hospitals out of the 195 non-federal hospitals offering surgery in 1980, or a 37.9% sample.

This was achieved by selection across the Province with respect to (a) geographic location, including variations in local population density, and (b) hospital size (total beds). Other minor criteria used were: (a) general versus specialty (e.g. orthopaedic, paediatric, cancer) hospitals, (b) teaching versus non-teaching hospitals, and (c) hospital control-private vs. public.

Size and Structure of the Studied Population

All persons potentially exposed to trace anesthetic gases as identified by the Director of Operating Room Nurses (or the Director of Nursing in Smaller Hospitals) in each of the 74 hospitals surveyed was completed and totalled 8040. From this total 1,443 were selected as a random sample.

Once the master list of exposed personnel was received from these 74 hospitals controls in a 1 to 3 ratio were requested with matching job and sex, but not age and smoking habits, from other departments within these hospitals e.g. Pediatrics, Psychiatry. A one-to-one ratio of matched controls was judged to be too large

considering the size of the exposed group. Job and sex matched controls were selected in addition from other hospitals in the same geographic location if unavailable in the same hospital. This was essential, particularly in the north where, in a small hospital, all staff are exposed to anesthetic gases through assisting at surgery or administering anesthesia. As a result control subjects were obtained from an additional 26 hospitals not included in the hygiene survey.

B. Design of Health Effects Study

Structure of the Questionnaire

A full copy of the questionnaire used in this study is presented in Appendix I. The questionnaire incorporated the American Society of Anesthesiologists (ASA) questionnaire in part in order to compare study findings.

The first two pages of the questionnaire were directly copied from that used by the ASA published in 1974. The third page was in the same format as the second page except that it requested reproductive information prior to the last 10 years, thus extending back further the reproductive history. The remaining four pages, collectively called the "Ontario Questionnaire" were designed to fill in the gaps that were perceived in the ASA Questionnaire viz. exposure of spouse (other than during pregnancy), menstrual abnormalities, infertility,

use of intrauterine contraceptive device, and other confounders for reproductive damage (alcohol intake, medications, smoking), and incidence of late developmental abnormalities or chronic disease in children. Instead of requesting social insurance numbers each respondent was assigned a unique code number as described later.

The structure of the Ontario portion contained a "General" questions section (Q1-Q8) followed by specific questions on Reproductive System - Women (Q9-Q16), and Reproductive System - Men (Q17-Q20).

Administration of the Questionnaire

A thirteen digit code was developed to be applied to each questionnaire to ensure confidentiality. These identified the region, hospital, present location within the hospital, present occupation, month/year of interview, interviewer's initials, cumulative number (interview/number/hospital - unique to worker) and how the questionnaire was administered i.e. self-administered, by interview or combination of both.

The medical service occupational health nurses normally distributed the questionnaire individually to each person, but some had to be distributed through the supervisior. In all cases, the respondent was requested to return the completed questionnaire directly to the nurse. The survey was conducted during the period 1981 - 1985.

C. Design of Hygiene, Air Sampling Components of Study

The study was designed to assess (A) the present anaesthetic exposures occurring and (B) the adequacy of exposure controls in place.

1. Industrial Hygiene Assessment

The contract hygienist conducted a walk-through survey of all locations (i.e. rooms or areas) where anaesthetic exposure could occur, compiling a total of such rooms for each hospital, by type of room, in order to develop an air sampling strategy for each hospital.

From this total, the hygienist selected a representative sample of rooms, the number varying with the size of the hospital, for an intensive follow-up hygiene assessment. This room assessment included the following:

(1) A characterization of and evaluation of the adequacy of general mechanical ventilation, including the presence of a positive pressure differential between the operating rooms and their environments. This survey included assessments both during surgery and when surgery was not in progress.

A tally sheet was used by the hygienist in his hygiene survey. In addition, he drew a sketch of the ventilation system for each room surveyed, with room dimensions and locations of the airflow measurements taken.

(2) An evaluation of the equipment used to administer anaesthesia, including:

(a) Whether a mechanical ventilator was being used or natural breathing was in effect;

(b) The percent makeup of the anesthetic mixture (and oxygen) being delivered to the patient, with flow rates;

(c) The dispensing source of the anesthetics used, whether from a cylinder or from a central supply pipeline;

(d) The types and safety features of the connections, e.g. unique pin indexing systems to prevent inappropriate connections by incompatible pin patterns;

(e) The type of breathing circuit;

(f) The type of breathing circuit-to-patient coupling (e.g. mask, endotracheal tube), together with whether problems of scale might favour leakage (as in paediatric cases) or whether surgery was located in the head or neck, where sealing against leaks may be hard to achieve; and

(g) The number and identity of halocarbon vapourizers attached to anesthetic machines, including the particular halocarbon vapourizer used during surgery.

(3) Whether a scavenger was present, was being used, was active or passive, was of commercial or in-house design and construction and the locations of scavenger inflow ports, whether at pressure relief (pop-off) valves or at ventilator exhalation valves or both.

2. Air Sampling, Analysis

Air sampling was conducted by two technicians who were also medically qualified persons familiar with operating room protocol.

The hygienist developed a "sampling strategy" for each hospital, a suggested list of numbers and types of rooms to be air sampled, so as to be representative of the relative frequency of the various types of rooms where exposure could occur. This strategy provided the technician with numbers and locations of area air samples to be taken, including locations of potential leak emissions, as well as numbers of workers to be sampled (breathing zone), by job category, appropriate to the size of the hospital.

The air sampling technicians followed the hygienist's sampling strategy either concurrent with the hygienist's survey or at a later date, since the hygiene survey usually required one day or less whilst the air sampling usually took longer, often several days, depending on hospital size. When the sampling technician arrived on a day different from the hygienist, different operating rooms might be in use than the ones surveyed by the hygienist and these were sampled.

a. Long-Term Sampling for Halocarbons

Long-term sampling for halocarbon vapours (halothane, enflurane and isoflurane, the latter having also the marketing name forane) was conducted by adsorption onto activated charcoal in glass tubes at a flow rate of 200 cc/minute.

Pump batteries were fully charged before use. Pumps were calibrated monthly on a bubble meter and the pump stroke rate was measured daily before use.

For non-scrubbed personnel, pumps were clipped onto the clothing and the charcoal tube inflow placed within that person's breathing zone. In this study, "breathing zone" means anywhere within a radius of 6 to 18 inches from the nose.

For scrubbed personnel, prior to scrubbing, the pump was attached at the waist and the charcoal tube was clipped to the non-sterile collar of the inner scrub dress/suit. The charcoal tube thus projected up above the sterile gown into the breathing zone.

For area samples, standard positioning of charcoal tubes was used.

b. Laboratory Analysis for Halocarbons

Following sampling, both tube ends were capped for transport to the Occupational Health Laboratory of the Ministry. The charcoal in the forward and rear sections was separately desorbed with carbon disulfide, analyzed and compared to blank tubes. Breakthrough was consistently less than the detection limit of the method.

A 2.0 microlitre aliquot of each carbon disulfide extract was analyzed by gas chromatography using a flame ionization detector, calibrated against standards of known concentrations of the expected halocarbon

analyte. Conditions of gas chromatography were column temperature of 50°C isothermal, using nitrogen as a carrier gas at a flowrate of 20 ml per minute. The injector and detector were maintained at 200°C. The stainless steel column (1/8-inch diameter, 10-foot length) was packed with 10% FFAP (free fatty acid phase) on Chromosorb WAW-DMCS 80/100.

Desorption efficiency for each of the three halocarbon analytes was measured to be 100%. The lower detection limit for this system was 0.01 mg (0.05 umoles) per sample.

c. Sampling for Nitrous Oxide, Direct Readout

The 1981 contract Pilot Study of 10 hospitals used true long-term air sampling for nitrous oxide (N_2O) gas, collecting air samples into Tedlar polymer film bags which were then sealed and transported to a aboratory for analysis by chromatography coupled to an electron capture detector. This bag method was cumbersome for sampling and analytic staff to handle, inconvenient for scrubbed-up staff, prone to leaks and excessively complicated and expensive for hospitals to use in routine air monitoring. Therefore, for the present study, a portable, direct readout infrared spectrophotometer was used, either a Vital Signs Nitrotest or a comparable Miran instrument. Such instruments rapidly measured air concentrations on site.

The advantages of direct readout instruments are (a) that the rapid readout allows serial monitoring of time trends, although this feature was not utilized, and (b) that it provides more data, increasing the statistical power of results. The disadvantage of this method is that the time-averaging of long-term sampling is no longer directly measurable. The NIOSH and Ontario guidelines for exposure to N_2O are time-weighted averages, depending, in concept, on long-term sampling. Therefore, it is necessary to infer a relation between a succession of rapidly read values and the corresponding value that would have been obtained from true long-term sampling under the same circumstances.

The technician set the zero reading with pure compressed air and used nitrous oxide 98 ppm span gas for calibration. The filter on the sample intake was changed daily. The instrument was stabilized for at least one half hour before measurement was begun.

The instrument was able to register N_2O levels up to 999 ppm.

In this report, it should be noted that the direct readout measurements, both "area" and "personal", were successions of serial short duration measurements, not long-term, time-integrated samples.

With the direct reading instrument, the probe had to be held in a fixed location for equilibration before the scale could be read. "Breathing zone" samples were defined to be a series of readings, each one taken without moving the probe, and were treated, in this study,

as the equivalent of "personal" samples. "Area" samples were similar successions of serial readings with the probe in a fixed location in the room. All these N_2O readings obtained at a fixed location were designated as zone serial readings (ZSRs). These successions of serial readings were each reported as a mean and a range.

d. TWA Calculations, Halogenated Vapours

For an average weekly exposure duration (hours) of TH for halothane, TE for enflurane, TI for isoflurane, and for respective time-averaged measured air levels of vapour (ppm) for halothane (H), enflurane (E) or isoflurane (I) then the estimated time weighted average exposure of a worker for each respective anesthetic vapour would be:

$$\text{TWA H} = \frac{H \times TH}{40}, \quad \text{for the exposure to halothane}$$

$$\text{TWA E} = \frac{E \times TE}{40}, \quad \text{for the exposure to enflurane, etc.}$$

In some individual cases, the average exposure duration per week exceeds 40 hours. This is reflected in the value generated by this formula for exposure.

e. TWA Calculations, Nitrous Oxide

Nitrous oxide ZSRs could only be made over a span of less than 15 minutes, usually about 5 to 10 minutes, at each sampling probe location. Given such a time frame, by the time a ZSR series had been recorded for each of several personnel in the operating room, the average operation would be completed.

We have to assume, therefore, that the ZSR series (N_1 $N_2 \ldots N_n$) obtained for each person sampled represents air levels representative of the span of time over which a theoretical

corresponding long-term sampling would have been performed, in order to arrive at a TWA measure of exposure.

The TWA for nitrous oxide (N) was calculated as

$$\text{TWA (N)} = \frac{\left(\frac{N_1 + \ldots N_n}{n}\right) \times \text{hours exposed to anesthetics per week}}{40 \text{ hours}}$$

D. Methods of Data Analysis

1) Health Effects

The goal of the data analysis was to determine whether exposure to anesthetics resulted in reproductive outcomes or chronic disease in exposed personnel using a job and sex comparable control group.

All respondents were divided into exposed and non-exposed groups according to the lifetime anesthetics exposure histories as obtained by the questionnaires. Within each of the exposure groups, the respondents were further divided into three broad occupational groups: doctors, nurses and others.

Those health effects included in the analysis were:

1. Chronic Diseases
   - cancer or leukemia
   - liver disease diagnosed during the 10 years prior to the administration of questionnaire
   - kidney disease in worker that had been diagnosed during the previous 10 years

2. Reproductive outcomes

   - spontaneous abortion
   - congenital abnormality in offspring

The possible independent effect of anesthetics on the various health effects was evaluated using Chi-square statistics. The exposure criterion included in the analysis only identified whether the respondent was ever exposed or the duration of exposure. i.e. the total accumulated exposure hours, and not the variability in levels of anaesthetic concentration.

The method used for calculating the standardised health effect rates was comparable to that used by the ASA AD HOC Committee study on Occupational disease among operating room personnel.

The rates for spontaneous abortion were based on the number of spontaneous abortions per 100 pregnancies reported, ignoring therapeutic abortions and pregnancies occurring prior to anesthetic exposure. Congenital abnormality rates were based on the number of live births with one to three reported abnormalities per 100 live births. For male respondents, all pregnancy results refer to the pregnancies of their spouses. The analyses took the results of pregnancy to be independent even though certain women provided reports on a number of pregnancies. Spontaneous abortion and congenital abnormality rates were standardized by the direct method (1) adjusted for both age and smoking habit of the mother at the time of pregnancy. The standard population used consisted of one third

smokers and two thirds non-smokers, with age distributions: 50 per cent less than 30 years of age; 40 per cent in the age range of 31-37 years; 10 per cent more than 37 years of age.

The LOGIST procedure of SAS (2, 3) was applied to fit the multiple logistic model to describe the binary health effects data, that is, value 0 represents 'had no effect' and value 1 represents 'had effect', in relation to anesthetics exposure adjusting for the possible confounding factors. To measure the strength of association between anesthetics exposure and various health effects, the estimated relative risk (odds ratio RR) was computed using the logistic regression coefficient. Ninety-five per cent confidence intervals for the relative risks were also calculated.

2) Hygiene Aspects

The General Linear Models procedure of SAS (4) was used to analyse the anesthetic gases environmental data. The analyses were performed using the arithematic and logarithmic means of area or breathing zone concentrations.

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2 SAS Supplemental Library User's Guide. Carry. NC.. SAS Institute Inc., 1980.

3 Breslow NE, Day NE. Statistical Methods in Cancer Research. Vol. 1. the Analysis of Case-Control Studies. Lyon: IARC Scientific Publications, 1980.

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E. REPORTING PROTOCOL

A report detailing the hygiene assessment, with observations, comments on the results of air sampling, and recommendation was sent to each hospital surveyed.

HEALTH SURVEY - RESULTS & DISCUSSION:

1. SURVEY POPULATION

Health Effects questionnaires were distributed to 10,551 individuals in one-hundred hospitals. The response rate was 78.8% (6,336) for the exposed group and 87.2% (2,202) for the non-exposed group.

The distribution of respondents' occupation (Doctors, Nurses and others) in non-exposed and exposed groups, and the responce rates are given in Table 1. The response rates for doctors was the lowest, but the total response was satisfactory being 87.2% for controls, 78.8% for exposed and 90.8% for the random sample of the exposed.

The distribution by age among respondents is shown in Table 2. There was a statistically significant difference in the mean age between the non-exposed and exposed group.

Table 3 shows the distribution by sex. There was a statistically significant difference in the sex distributions between the non-exposed and the exposed group.

2. ANESTHETIC EXPOSURE

The weekly exposure hours for operating room personnel as derived from questionnaires and hygienist's visits ranged from two hours to 65 hours (Table 4).

Table 5 shows the distribution of total lifetime exposure hours to anesthetics for all workers in the exposed group, and Table 6 shows the distribution of total lifetime exposure hours for those workers in the random sample. The formulas used for the calculation of lifetime exposure depended on the history detail and were as follows:

number hours exposed/day x number days/week x 46 weeks/year x number years,or

number hours exposed/day x 19.25 days/month x number months.

3. FREQUENCY OF CHRONIC DISEASE

Table 7 gives the frequency distribution of the health effects in workers.

The possible independent effect of anaesthetic exposure on the four categories of health problems was evaluated first. Chi-square statistics showed that there were no differences between the non-exposed and the exposed groups, and between the non-exposed group and the random sample in reports of cancer or leukemia, liver, kidney or other health problems at the 5% significant level. The reported health effects are listed in Appendix C.

Table 8 shows the distribution of reported health effects by method of questionnaire administration (self-administration, interview, and the combination of the two). The method of questionnaire administration did not seem to be a factor in the reporting of cancer/leukemia, liver and kidney diseases.

Table 9 shows the distribution of reported health effects by occupation group. Nurses in the exposed and random groups showed a significantly higher risk of "other" health problem.

Table 10 shows the distribution of reported health effects by region. The geographic region did not seem to be an important factor in the reporting of cancer/leukemia, liver and kidney diseases.

Table 11 shows the distribution of reported health effects by residential/districts. District did not seem to be an important factor in the reporting of cancer/leukemia, liver and kidney diseases.

Tables 12 and 13 show the multiple logistic model results.

The multiple explanatory variables which were considered in the logistic regression equations are as follows:

-Exposure to anaesthetics is a dichotomous ordinal variable; value 0 is assigned to non-exposed workers and value 1 is assigned to exposed workers;

- Age is a continuous variable which ranges from 15 to 77 years old. The age used in the equation is the age of the worker in the questionnaire completion year, but in the case of exposed workers who had cancer or leukemia the age was calculated at the cancer or leukemia onset year;

- Sex is a dichotomous ordinal variable with value 0 assigned to female workers, and value 1 assigned to male workers;

- Medication taking is a dichotomous ordinal variable. Value 0 is assigned to workers taking no medication, and value 1 is assigned to workers who had taken medication, for relaxation, sleep or to kill pain.

- Drinking habit is a dichotomous ordinal variable with value 0 assigned to workers who do not drink socially, and value 1 assigned to social drinkers.

- Smoking habit is a dichotomous ordinal variable with value 0 assigned to workers who did not smoke in the past, and value 1 assigned to those who smoked in the past.

- occupation group is a nominal variable consisting of 2 variables: OCCN1 and OCCN2. Doctor group is represented by assigning value 1 to OCCN1 and value 0 to OCCN2, nurse group is represented by assigning value 0 to OCCN1 and value 1 to OCCN2, and occupation other than doctor and nurse is represented by assigning 0 to both OCCN1 and OCCN2.

In Table 12, the multivariate logistic regression comparative analysis of all exposed from non-exposed showed an adjusted odds ratio points estimate (RR) of 0.90 with 95% confidence limits of 0.62 and 1.32 for cancer or leukemia; an adjusted odds ratio points estimate of 1.32 with 95% confidence limits of 0.85 and 2.05 for liver problem; an adjusted odds ratio points estimate of 1.14 with 95% confidence limits of 0.88 and 1.49 for kidney problem; and an adjusted odds ratio points of 0.90 with 95% confidence limits of 0.80 and 1.02 for "other" health problems.

In Table 13, the multivariate logistic regression comparative analysis of exposed random sample from non-exposed showed an adjusted odds ratio points estimate (RR) of 0.64 with 95% confidence limits of 0.35 and 1.15 for cancer or leukemia; an adjusted odds ratio points estimate of 1.11 with 95% confidence limits of 0.61 and 2.01 for liver problem; an adjusted odds ratio points estimate of 0.97 with 95% confidence limits of 0.66 and 1.42 for kidney problem; and an adjusted odds ratio points estimate of 0.87 with 95% confidence limits of 0.74 and 1.03 for "other" health problem.

The total exposure hours prior to cancer or leukemia occurrence was only available for 103 of the cancer or leukemia occurrences in the exposed group, and the distribution of these cumulated exposure hours is shown in Table 14.

The correlation of cancer or leukemia occurrence with the accumulated exposure hours up to the cancer or leukemia onset year, as well as to the accumulated exposure hours adjusting for factors identified in Table 12 are evaluated in Table 15, by logistic regression. The relative risk of cancer

or leukemia occurrence from exposure to anesthetics was calculated using the regression coefficient obtained for every 10,000 accumulated exposure hours prior to cancer or leukemia occurrence.

Four models are presented in Table 15. Models #1 and #2 examine the comparison of exposed workers with non-exposed workers, and models #3 and #4 examine the comparison of the random sample with the non-exposed workers.

The results indicate that there is very little difference in incidence between the exposed and non-exposed groups.

4. REPRODUCTIVE OUTCOMES

16,724 pregnancies were reported by 5,980 workers. 3,656 were reported by the non-exposed workers, 13,068 by the exposed workers, and 2,936 pregnancies by exposed workers in the random sample. Of the 13,068 pregnancies reported by the exposed workers, 2,836 pregnancies occurred prior to exposure to anaesthetics, 9,839 after exposure, and 393 were reported without indication to exposure period. Those pregnancies occurring prior to exposure have been excluded from the analysis.

The distribution of pregnancy results by respondent's sex, exposure status and occupation group is shown in Table 16. For male respondents, all results refer to the pregnancies of their spouses. As shown, the 13,888 pregnancy outcomes reported were as follows: 11,879 (85.5%) live births, 109 (0.8%) still births, 1,694 (12,2%) spontaneous abortions, 149 (1.1%) therapeutic abortion and 57 (0.4%) unknown. Excluding the 57 unknown, a comparison of distribution of pregnancy outcomes in the non-exposed and the exposed workers, and between the non-exposed and the random sample indicated an overall significance at 5% level. (chi-square 14.2 and 8.1 respectively)

The rates for spontaneous abortion were based on the number of spontaneous abortions per 100 pregnancies reported, ignoring therapeutic abortions in both the numerator and denominator. Table 17 shows that there is a

significant increase in the frequency of spontaneous abortions amongst exposed females other than doctors as compared to the non-exposed workers. A significant increase in the frequency of spontaneous abortions was also observed in wives of exposed male respondents except with nurses.

The LOGIST procedure of SAS was used to fit the multiple logistic model to provide an estimate of the probability of spontaneous abortion as a function of all the simultaneous variables. The results are shown in Table 18. The statistical analysis took the events to be independent even though certain women reported several pregnancies.

The multiple explanatory variables which were considered in the logistic regression equation are:

- Anaesthetics exposure is a dichotomous ordinal variable; value 0 is assigned to non-exposed workers, and value 1 is assigned exposed (or random sample) workers;

- Birth order is a continuous variable which ranges from 1 to 14;

- Age of mother at the time of pregnancy is a continous variable which ranges from 14 to 47 years old;

- Smoking habit of the mother during pregnancy is an ordinal variable; value 0 is assigned to no smoking during pregnancy, value 1 is assigned to daily consumption of less than 20 cigarettes, and value 2 is assigned to daily consumption of more than 20 cigarettes;

- Previous spontaneous abortion is a dichotomous ordinal variable; value 0 is assigned to no history of previous spontaneous abortion, and value 1 is assigned to occurrence of previous spontaneous abortion.

- Occupation is a nominal variable consisting of two variables OCCN 1 and OCCN 2. Doctor is represented by assigning value 1 to OCCN 1 and value 0 to OCCN 2, nurse is represented by assigning value 0 to OCCN 1 and value 1 to OCCN 2, and occupation other than doctor and nurse is representd by assigning value 0 to both OCCN 1 and OCCN 2.

In Table 18, the multivariate logistic regression comparative analysis of female exposed workers from female non-exposed workers (model #1) shows an adjusted odds ratio points (RR) estimate of 1.55 with 95% confidence limits of 1.27 and 1.89. The comparison of the female random sample group with the female non-exposed workers (model #2) shows an adjusted odds ratio points estimate of 1.66 with 95% confidence limits of 1.26 and 2.20. The comparison of spouses of the male exposed workers with spouses of male non-exposed workers (model #3) shows an adjusted odds ratio points estimate of 2.30 with 95% confidence limits of 1.69 and 3.13. The comparison of spouses of the male random sample group with the spouses of the male non-exposed workers (model #4) shows an adjusted odds ratio points estimate of 2.72 with 95% confidence limits of 1.85 and 4.01. Spontaneous abortion was also found to be recurrent.

Another set of analyses replacing the binary anaesthetics exposure variable by the respondent's calculated accumulated exposure hours up to pregnancy showed a similar effect of exposure on spontaneous abortions (Table 18).

Table 19 shows the distribution of congenital abnormalities among live births by exposure and occupation groups. One to three abnormalities were reported in 892 children including 181 children of non-exposed workers, 711 children of exposed workers and 145 children of exposed workers in the random sample. The 892 incidences of congenital abnormalities are listed in Appendix C.

Table 20 shows the rate of congenital abnormalities in children of the exposed and non-exposed respondents. Increased congenital abnormality rates were observed among childern of exposed female doctors and nurses as compared to children of non-exposed workers, however this was not observed in children of exposed male respondents.

In Table 21, the multivariate logistic regression comparative analysis of congenital abnormalities in children of female exposed workers from children of non-exposed female workers (Model #1) shows an adjusted odds ratio points estimate of 1.91 with 95% confidence limits of 1.50 and 2.42 continues. The comparison of children of females in the random sample from children of female non-exposed workers (Model #2) shows an adjusted odds ratio points estimate of 2.04 with 95% confidence limits of 1.46 and 2.86. The comparison of children of male exposed workers from children of male non-exposed workers (Model #3) shows an adjusted odds ratio point

extimate of 1.46 with 95% confidence limits of 1.04 and 2.05. The comparison of children of male random sample and children of male non-exposed workers (Model #4) shows an adjusted odds ratio points estimate of 1.31 with 95% confidence limits of 0.85 and 2.01.

Table 22 shows the distribution of Cancer or Leukemia in children. A total of 24 occurrences of Cancer or Leukemia were reported including three occurrences in children of non-exposed workers, 21 occurrences in children of exposed workers (three occurrences in children of the randon sample). The Cancer or Leukemia occurrences in children are shown in Appendix C.

TABLE 1

DISTRIBUTION OF RETURNED QUESTIONNAIRES BY OCCUPATION GROUP

Occupation	#	Non-Exposed Response Rate(%)	#	Exposed Response Rate(%)	#	Random Sample Response Rate
Doctors	479 (21.7%)	62.2	2,373 (37.5%)	67.3	560 (38.8%)	84.4
Nurses	911 (41.4%)	97.4	3,038 (47.9%)	90.0	633 (43.9%)	96.6
Others	812 (36.9%)	86.8	925 (14.6%)	88.9	250 (17.3%)	95.0
TOTAL	2,202 (100%)	87.2	6,336 (100%)	78.8	1,443 (100%)	90.8

TABLE 2

DISTRIBUTION BY AGE

Age	Non-Exposed	Exposed	Random Sample
under 25	267 (12.1%)	204 (3.2%)	57 (4.0%)
25-29	429 (19.5%)	712 (11.2%)	152 (10.5%)
30-34	400 (18.2%)	1,119 (17.7%)	249 (17.3%)
35-39	340 (15.4%)	1,163 (18.4%)	254 (17.6%)
40-44	212 (9.6%)	971 (15.3%)	219 (15.2%)
45-49	195 (8.9%)	751 (11.8%)	189 (13.1%)
50-54	148 (6.7%)	612 (9.7%)	132 (9.1%)
55-59	109 (5.0%)	433 (6.8%)	94 (6.5%)
60-64	76 (3.5%)	249 (3.9%)	64 (4.4%)
65 and over	23 (1.0%)	112 (1.8%)	28 (1.9%)
unknown	3 (0.1%)	10 (0.2%)	5 (0.4%)
TOTAL	2,202 (100%)	6,336 (100%)	1,443 (100%)
Mean (year)	36.89	40.82	40.93
S.D.	11.33	10.67	10.80

* There was a statistically significant difference in the mean age between the non-exposed and the exposed group, and between the non-exposed group and the random sample. There was no statistically significant difference in the mean age between the exposed group and the random sample.

TABLE 3

DISTRIBUTION BY SEX

Sex	Non-Exposed	Exposed	Random Sample
Female	1,472 (67.0%)	3,820 (60.3%)	824 (57.1%)
Male	726 (33.0%)	2,512 (39.7%)	619 (42.9%)
TOTAL*	2,198 (100%)	6,332 (100%)	1,443 (100%)

* Four workers in the non-exposed group and four workers in the exposed group did not indicate sex.

** There was a statistically significant difference in the sex distribution between the non-exposed and the exposed groups, and between the non-exposed group and the random sample. There was no statistically significant difference in the sex distribution between the exposed group and the random sample.

TABLE 4

DISTRIBUTION OF WEEKLY EXPOSURE HOURS

OCCUPATION	WEEKLY EXPOSURE HOURS RANGE IN HOURS	MEAN
Anesthetist	3 - 65	33.2
Scrub nurse	3 - 40	31.4
OR Technician	27.5 - 40	37.2
OR Circulating nurse	3 - 40	34.1
Orderly	25 - 40	36.8
Surgeon	2 - 42	12.8

TABLE 5

DISTRIBUTION OF LIFETIME EXPOSURE HOURS TO ANAESTHETIC GASES IN THE EXPOSED GROUP

Total Lifetime Exposure Hours to ANAS	# of Workers	Percent
12-500	562	9.2
501-1,000	431	7.0
1,001-2,000	536	8.7
2,001-3,000	349	5.7
3,001-4,000	311	5.1
4,001-5,000	233	3.8
5,001-6,000	271	4.4
6,001-7,000	200	3.3
7,001-8,000	175	2.9
8,001-9,000	179	2.9
9,001-10,000	171	2.8
10,001-15,000	778	12.7
15,001-20,000	586	9.6
20,001-25,000	431	7.0
25,001-30,000	270	4.4
30,001-35,000	219	3.6
35,001-40,000	143	2.3
40,001-50,000	154	2.5
50,001-96,140	131	2.1
TOTAL	**6,130**	**100.0**

Median: 7,964.5 Hours

TABLE 6

DISTRIBUTION OF LIFETIME EXPOSURE HOURS TO ANAESTHETIC GASES IN THE RANDOM SAMPLE

Total Lifetime Exposure Hours to ANAS	# of Workers	Percent
18-500	54	3.8
501-1,000	64	4.5
1,001-2,000	95	6.6
2,001-3,000	77	5.4
3,001-4,000	87	6.1
4,001-5,000	52	3.6
5,001-6,000	65	4.6
6,001-7,000	53	3.7
7,001-8,000	44	3.1
8,001-9,000	51	3.6
9,001-10,000	41	2.9
10,001-15,000	216	15.1
15,001-20,000	153	10.7
20,001-25,000	123	8.6
25,001-30,000	74	5.2
30,001-35,000	57	4.0
35,001-40,000	44	3.1
40,001-50,000	39	2.7
50,001-96,140	38	2.7
TOTAL	**1,427**	**100.0**

Median 10,350.0 Hours

TABLE 7

DISTRIBUTION OF REPORTED HEALTH EFFECTS

Health Effect	Non-Exposed		Exposed			Random Sample		
	Had Effect	Had No Effect	Had Effect	Had No Effect	Odds* Ratio (p-value)	Had Effect	Had No Effect	Odds Ratio (p-value)
Cancer/ Leukemia	41	2,150	122	6,168	1.03 (0.84)	18	1,409	0.66 (0.15)
Liver Problem	26	2,108	105	5,906	1.44 (0.09)	20	1,326	1.22 (0.50)
Kidney Problem	76	2,063	259	5,782	1.21 (0.14)	47	1,303	0.97 (0.91)
Other Health Problem	530	1,671	1,545	4,781	1.01 (0.74)	333	1,108	0.94 (0.50)

* Odds ratio is the odds in favour of having the disease

TABLE 8

DISTRIBUTION OF REPORTED HEALTH EFFECTS BY QUESTIONNAIRE ADMINISTRATION METHOD

Health Effect	Administration Method	Non-Exposed		Exposed			Random Sample		
		Had Effect	Had No Effect	Had Effect	Had No Effect	Odds Ratio (p-value)	Had Effect	Had No Effect	Odds Ratio (p-value)
Cancer/ Leukemia	self-administration	11	553	20	1,585	0.63 (0.22)	4	403	0.49 (0.22)
	interview	20	1,262	45	1,870	1.51 (0.12)	9	425	1.33 (0.47)
	combined	10	335	57	2,712	0.70 (0.31)	5	581	0.28 (0.01)
Liver Problem	self-administration	8	521	36	1,456	1.61 (0.22)	8	369	1.41 (0.49)
	interview	14	1,266	26	1,872	1.25 (0.49)	2	415	0.43 (0.26)
	combined	4	321	43	2,577	1.33 (0.57)	10	542	1.48 (0.51)
Kidney Problem	self-administration	20	511	63	1,433	1.12 (0.65)	12	365	0.84 (0.63)
	interview	46	1,236	78	1,820	1.15 (0.45)	10	406	0.66 (0.24)
	combined	10	316	118	2,528	1.47 (0.24)	25	532	1.48 (0.29)
Other Health Problem	self-administration	115	451	363	1,255	1.13 (0.29)	89	326	1.07 (0.66)
	interview	333	956	489	1,440	0.97 (0.75)	91	346	0.75 (0.03)
	combined	82	262	692	2,084	1.06 (0.65)	152	435	1.11 (0.48)

TABLE 9

DISTRIBUTION OF REPORTED HEALTH EFFECTS BY OCCUPATION GROUP

Health Effect	Occupation Group	Non-Exposed		Exposed			Random Sample		
		Had Effect	Had No Effect	Had Effect	Had No Effect	Odds Ratio (p-value)	Had Effect	Had No Effect	Odds Ratio (p-value)
Cancer/ Leukemia	Doctor	11	464	61	2,293	1.12 (0.72)	10	544	0.77 (0.56)
	Nurse	12	896	53	2,971	1.33 (0.37)	7	623	0.83 (0.71)
	Other	18	790	8	904	0.38 (0.02)	1	242	0.18 (0.06)
Liver Problem	Doctor	9	454	58	2,203	1.32 (0.43)	9	515	0.88 (0.79)
	Nurse	11	872	38	2,829	1.06 (0.85)	7	582	0.95 (0.92)
	Other	6	782	9	874	1.34 (0.57)	4	229	2.27 (0.19)
Kidney Problem	Doctor	14	451	83	2,177	1.22 (0.48)	16	506	1.01 (0.96)
	Nurse	31	851	142	2,748	1.41 (0.08)	27	568	1.30 (0.32)
	Other	31	761	34	857	0.97 (0.91)	4	229	0.42 (0.10)
Other Health Problem	Doctor	79	400	455	1,913	1.20 (0.16)	93	467	1.00 (0.96)
	Nurse	200	711	851	2,183	1.38 (0.0003)	173	459	1.33 (0.01)
	Other	251	560	239	685	0.77 (0.01)	67	182	0.82 (0.22)

TABLE 10

DISTRIBUTION OF REPORTED HEALTH EFFECTS BY REGION

Health Effect	Region	Non-Exposed		Exposed			Random Sample		
		Had Effect	Had No Effect	Had Effect	Had No Effect	Odds Ratio (p-value)	Had Effect	Had No Effect	Odds Ratio (p-value)
Cancer/ Leukemia	Hamilton	7	470	25	1,397	1.20 (0.67)	4	327	0.82 (0.75)
	London	10	376	19	1,044	0.68 (0.33)	2	231	0.32 (0.12)
	Ottawa	3	199	9	523	1.14 (0.84)	2	124	1.06 (0.94)
	Sudbury	4	164	5	403	0.50 (0.31)	0	93	- -
	Toronto East	5	428	28	1,236	1.93 (0.17)	5	310	1.38 (0.61)
	Toronto West	12	513	36	1,565	0.98 (0.96)	5	324	0.65 (0.43)
Liver Problem	Hamilton	6	455	16	1,341	0.90 (0.83)	3	317	0.71 (0.64)
	London	7	378	22	1,036	1.14 (0.75)	3	226	0.71 (0.63)
	Ottawa	2	194	6	484	1.20 (0.82)	2	114	1.70 (0.59)
	Sudbury	2	152	10	378	2.01 (0.36)	3	87	2.62 (0.29)
	Toronto East	5	414	21	1,147	1.51 (0.40)	3	279	0.89 (0.87)
	Toronto West	4	515	30	1,520	2.54 (0.08)	6	303	2.54 (0.14)
Kidney Problem	Hamilton	26	438	61	1,302	0.78 (0.32)	11	307	0.60 (0.16)
	London	12	373	35	1,022	1.06 (0.85)	6	223	0.83 (0.72)
	Ottawa	7	192	25	470	1.45 (0.38)	4	112	0.97 (0.97)
	Sudbury	1	152	23	368	9.50 (0.02)	5	84	9.04 (0.01)
	Toronto East	17	403	48	1,125	1.01 (0.96)	7	276	0.60 (0.26)
	Toronto West	13	505	67	1,495	1.74 (0.07)	14	301	1.80 (0.13)
Other Health Problem	Hamilton	130	347	385	1,042	0.98 (0.90)	73	260	0.74 (0.08)
	London	77	310	216	856	1.01 (0.91)	34	200	0.68 (0.09)
	Ottawa	42	165	132	402	1.29 (0.20)	31	98	1.24 (0.41)
	Sudbury	45	123	101	308	0.89 (0.59)	25	68	1.00 (0.98)
	Toronto East	91	345	293	983	1.13 (0.36)	79	241	1.24 (0.21)
	Toronto West	145	381	418	1,190	0.92 (0.47)	91	241	0.99 (0.96)

TABLE 11

DISTRIBUTION OF REPORTED HEALTH EFFECTS
BY RESIDENTIAL DISTRICT

Health Effect	Residential District	Non-Exposed		Exposed			Random Sample		
		Had Effect	Had No Effect	Had Effect	Had No Effect	Odds Ratio (p-value)	Had Effect	Had No Effect	Odds Ratio (p-value)
Cancer/ Leukemia	Rural	5	254	18	835	1.09 (0.85)	4	173	1.17 (0.81)
	Suburban	11	784	50	2,532	1.40 (0.30)	5	599	0.59 (0.33)
	Urban	24	1,088	52	2,709	0.87 (0.57)	8	614	0.59 (0.19)
Liver Problem	Rural	5	237	12	794	0.71 (0.53)	0	166	- -
	Suburban	9	772	35	2,42	1.22 (0.58)	11	555	1.70 (0.24)
	Urban	12	1,079	56	2,586	1.94 (0.03)	7	585	1.07 (0.87)
Kidney Problem	Rural	9	235	35	777	1.17 (0.66)	8	161	1.29 (0.59)
	Suburban	29	756	105	2,386	1.14 (0.52)	20	545	0.95 (0.88)
	Urban	38	1,052	117	2,536	1.27 (0.19)	19	576	0.91 (0.75)
Other Health Problem	Rural	64	194	187	671	0.84 (0.30)	35	143	0.74 (0.20)
	Suburban	199	598	684	1,901	1.08 (0.40)	155	448	1.03 (0.75)
	Urban	261	858	651	2,128	1.00 (0.94)	137	490	0.91 (0.48)

TABLE 12

LOGISTIC REGRESSION EQUATION FOR THE HEALTH EFFECTS OF ANAESTHETICS EXPOSURE - ALL EXPOSED VERSUS NON-EXPOSED

Health Effect	REGRESSION COEFFICIENTS (P-VALUE IN PARENTHESES)									Model p-value
	Intercept	Anaesthetics Exposure	Age	Sex	Medication	Drinking	Smoking	OCCN1	OCCN2	
Cancer/ Leukemia	-4.55	-0.09 RR=0.90 (0.61)	0.005 RR=1.01 (0.44)	-0.42 RR=0.65 (0.10)	0.42 RR=1.53 (0.04)		0.33 RR=1.39 (0.04)	0.86 RR=2.38	0.08 RR=1.09	0.004
Liver Problem	-4.50	0.28 RR=1.32 (0.20)	0.0008 RR=1.00 (0.92)	0.84 RR=2.33 (0.00)	0.68 RR=1.99 (0.001)	-0.48 RR=0.61 (0.01)				0.00
Kidney Problem	-3.51	0.13 RR=1.14 (0.30)	0.006 RR=1.00 (0.24)	-0.20 RR=0.81 (0.10)	0.69 RR=2.00 (0.00)	-0.06 RR=0.94 (0.66)				0.00
Other Health Problem	-2.23	-0.09 RR=0.90 (0.11)	0.02 RR=1.02 (0.00)	-0.54 RR=0.58 (0.00)	1.06 RR=2.89 (0.00)	-0.08 RR=0.92 (0.22)	0.16 RR=1.17 (0.002)			0.00

Variable Range:

Anaesthetics exposure: 0=non-exposed
1=exposed

Age: 18-77 years (15-77 for cancer/leukemia)

Sex: 0=female 1=male

Medication: 0=no medication taken
1=medication was taken for relaxation, sleep or kill pain

Drinking: 0=not drinking
1=social drinking

Smoking: 0=not smoking, ever
1=smoking, ever

OCCN1, OCCN2: Occupational Group

Doctor: OCCN1=1, OCCN2=0
Nurse: OCCN1=0, OCCN2=1
Other: OCCN1=0, OCCN2=0

Key:- RR = Relative risk (odds ratio)

TABLE 13

LOGISTIC REGRESSION EQUATION FOR THE HEALTH EFFECTS OF ANAESTHETICS EXPOSURE - RANDOM SAMPLE VERSUS NON-EXPOSED

Health Effect	REGRESSION COEFFICIENTS (P-VALUE IN PARENTHESES)									Model p-value
	Intercept	Anaesthetics Exposure	Age	Sex	Medication	Drinking	Smoking	OCCN1	OCCN2	
Cancer/ Leukemia	-3.88	-0.44 RR=0.64 (0.13)	-0.002 RR=0.99 (0.82)	-0.64 RR=0.52 (0.10)	0.53 RR=1.70 (0.12)		0.14 RR=1.15 (0.58)	0.81 RR=2.26	-0.37 RR=0.68	0.16
Liver Problem	-4.79	0.10 RR=1.11 (0.72)	0.006 RR=1.00 (0.63)	0.47 RR=1.61 (0.13)	0.84 RR=2.33 (0.01)	-0.18 RR=0.82 (0.59)				0.11
Kidney Problem	-3.07	-0.02 RR=0.97 (0.89)	-0.002 RR=0.99 (0.77)	-0.12 RR=0.88 (0.56)	0.61 RR=1.85 (0.01)	-0.21 RR=0.80 (0.31)				0.09
Other Health Problem	-2.20	-0.13 RR=0.87 (0.10)	0.02 RR=1.02 (0.00)	-0.61 RR=0.54 (0.00)	0.95 RR=2.60 (0.00)	-0.05 RR=0.94 (0.59)	0.19 RR=1.22 (0.01)			0.00

Variable Range:

Anaesthetics exposure: 0=non-exposed
1=exposed

Age: 18-77 years (15-76 for cancer/leukemia)

Sex: 0=female
1=male

Medication: 0=no medication taken
1=medication was taken for relaxation, sleep or kill pain

Drinking: 0=not drinking
1=social drinking

Smoking: 0=not smoking, ever
1=smoking, ever

OCCN1, OCCN2: Occupational Group
Doctor: OCCN1=1, OCCN2=0
Nurse: OCCN1=0, OCCN2=1
Other: OCCN1=0, OCCN2=0

TABLE 14

DISTRIBUTION OF TOTAL EXPOSURE HOURS TO ANAESTHETIC GASES PRIOR TO CANCER OR LEUKEMIA OCCURRENCE IN THE EXPOSED GROUP

Total Cumulated Exposure Hours to ANAS Prior to Cancer/Leukemia	# of Workers	Percent
161-500	6	5.8
501-1,000	2	1.9
1,001-2,000	5	4.9
2,001-3,000	7	6.8
3,001-4,000	6	5.8
4,001-5,000	4	3.9
5,001-6,000	4	3.9
6,001-7,000	5	4.9
7,001-8,000	3	2.9
8,001-9,000	3	2.9
9,001-10,000	3	2.9
10,001-11,000	7	6.8
11,001-12,000	3	2.9
12,001-13,000	4	3.9
13,001-14,000	3	2.9
14,001-15,000	5	4.9
15,001-16,000	3	2.9
16,001-17,000	5	4.9
17,001-18,000	2	1.9
18,001-19,000	2	1.9
20,001-25,000	4	3.9
25,001-30,000	7	6.8
30,001-40,000	5	4.9
40,001-69,483	5	4.9
TOTAL	**103**	**100%**

Median: 10,350 Hours

TABLE 15

LOGISTIC REGRESSION EQUATION FOR CANCER/LEUKEMIA OF ANAESTHETICS EXPOSURE HOURS

	REGRESSION COEFFICIENTS (P-VALUE IN PARENTHESES)							
Model #	Intercept	Anaesthetics Exposure (10,000 hours)	Age	Sex	Medication	Smoking	OCCN1	OCCN2	Model p-value
1.	-4.07	0.04 RR=1.04 (0.44)							0.44
2.	-4.42	0.02 RR=1.02 (0.67)	-0.0007 RR=0.99 (0.93)	-0.56 RR=0.56 (0.05)	0.43 RR=1.54 (0.05)	0.43 RR=1.54 (0.02)	0.83 RR=2.30	-0.02 RR=0.97	0.008
3.	-4.02	-0.14 RR=0.86 (0.32)							0.32
4.	-4.02	-0.16 RR=0.85 (0.29)	-0.0004 RR=0.99 (0.97)	-0.66 RR=0.51 (0.10)	0.52 RR=1.69 (0.12)	0.15 RR=1.16 (0.57)	0.76 RR=2.15	-0.38 RR=0.67	0.22

Models 1 & 2: all exposed versus non-exposed workers
3 & 4: random sample versus non-exposed workers

Variable Range:

Anaesthetics exposure: non-exposed = 0
exposed group = total ANAS exposure hours prior to cancer or leukemia occurrence or questionnaire administered year

Age: 15-77 years

Sex: 0=female
1=male

Medication: 0=no medication taken
1=medication was taken for relaxation, sleep or kill

Drinking: 0=not drinking
1=social drinking

Smoking: 0=not smoking, ever
1=smoking, ever

OCCN1, OCCN2: Occupational Group
Doctor: OCCN1=1, OCCN2=0
Nurse: OCCN1=0, OCCN2=1
Other: OCCN1=0, OCCN2=0

Key:- RR = Relative risk (odds ratio)

TABLE 16

RESULTS OF PREGNANCY BY
EXPOSURE AND OCCUPATIONAL GROUPS

SEX OF RESPONDENT	EXPOSURE GROUP	OCCUPATION GROUP	RESULT OF PREGNANCY: LIVE BIRTH	STILL BIRTH	SPONTANEOUS ABORTION	THERAPEUTIC ABORTION	UNKNOWN RESULTS	TOTAL
Female	Non-exposed	Doctor	100	1	14	2	-	117
		Nurse	918	6	136	16	2	1078
		Other	772	9	116	21	-	918
		Sub-Total	1790	16	266	39	2	2113
			(84.7%)	(0.8%)	(12.6%)	(1.8%)	(0.1%)	(100%)
	Exposed	Doctor	300	2	47	14	2	365
		Nurse	3332	35	638	48	2	4055
		Other	188	6	41	3	1	239
		Sub-total	3820	43	726	65	5	4659
			(82.0%)	(0.9%)	(15.6%)	(1.4%)	(0.1%)	(100%)
	Random Sample	Doctor	57	1	6	3	-	67
		Nurse	607	7	121	9	1	745
		Other	34	1	10	1	1	47
		Sub-total	698	9	137	13	2	859
			(81.3%)	(1.0%)	(16.0%)	(1.5%)	(0.2%)	(100%)
Male	Non-exposed	Doctor	899	5	71	8	6	989
		Nurse	45	1	7	2	-	55
		Other	431	2	52	2	3	490
		Sub-total	1375	8	130	12	9	1534
			(89.6%)	(0.5%)	(8.5%)	(0.8%)	(0.6%)	(100%)
	Exposed	Doctor	4603	33	529	31	40	5236
		Nurse	117	2	12	1	-	132
		Other	158	7	31	1	1	198
		Sub-total	4878	42	572	33	41	5566
			(87.6%)	(0.8%)	(10.3%)	(0.6%)	(0.7%)	(100%)
	Random Sample	Doctor	1163	5	124	2	5	1299
		Nurse	27	1	-	-	-	28
		Other	31	1	6	-	1	39
		Sub-total	1221	7	130	2	6	1366
			(89.4%)	(.05%)	(9.5%)	(0.2%)	(0.4%)	(100%)
Unknown Sex	Non-exposed	Doctor	3	-	-	-	-	3
		Nurse	3	-	-	-	-	3
		Other	3	-	-	-	-	3
		Sub-total	9	-	-	-	-	9
			(100%)					(100%)
	Exposed	Doctor	7	-	-	-	-	7
			(100%)					(100%)
TOTAL			11879	109	1694	149	57	13888
			(85.5%)	(0.8%)	(12.2%)	(1.1%)	(0.4%)	(100%)

TABLE 17

SPONTANEOUS ABORTION RATES FOR EXPOSURE AND OCCUPATION GROUPS

FEMALE RESPONDENTS

OCCUPATION	EXPOSED*	NON-EXPOSED*	SIGNIFICANCE
DOCTORS	13.5±2.1 (341)	9.2±3.0 (106)	N.S.
NURSES	16.5±0.8 (3913)	10.5±1.4 (1020)	P 0.05
OTHERS	22.0±3.5 (229)	9.6±1.5 (860)	P 0.05

WIVES OF MALE RESPONDENTS

OCCUPATION	EXPOSED	NON-EXPOSED	SIGNIFICANCE
DOCTORS	9.3±0.5 (4736)	3.5±0.7 (848)	P 0.05
NURSES	9.6±2.7 (126)	9.7±3.8 (51)	N.S.
OTHERS	19.7±3.8 (182)	7.4±1.4 (467)	P 0.05

Rate per 100 pregnancies is standardized for age and smoking with standard error and total number of pregnancies in parentheses.

TABLE 18

LOGISTIC REGRESSION EQUATIONS FOR THE EFFECT OF ANAESTHETICS ON SPONTANEOUS ABORTIONS

MODEL #	INTERCEPT	ANAS EXPOSURE	BIRTH ORDER	AGE OF MOTHER AT PREGNANCY	SMOKING DURING PREGNANCY	PREVIOUS SPONTANEOUS ABORTION	OCCN 1	OCCN 2	MODEL P-VALUE
1	- 2.83	0.44 RR=1.55 (0.00)	- 0.002 RR=0.99 (0.95)	0.01 RR=1.01 (0.13)	0.06 RR=1.07 (0.27)	0.92 RR=2.50 (0.00)	- 0.28 RR=0.74 (N.S)	- 0.01 RR=0.98	0.00
2	- 2.13	0.50 RR=1.66 (0.0005)	- 0.05 RR=0.94 (0.32)	- 0.01 RR=0.99 (0.56)	0.06 RR=1.06 (0.53)	1.05 RR=2.87 (0.00)	- 0.17 RR=0.84 (N.S)	0.01 RR=1.01	0.00
3	- 3.02	0.83 RR=2.30 (0.00)	0.05 RR=1.05 (0.15)	0.007 RR=1.01 (0.57)	- 0.08 RR=0.92 (0.29)	0.62 RR=1.86 (0.00)	- 0.67 RR=0.51 (Sig)	- 0.15 RR=0.85	0.00
4	- 3.30	1.00 RR=2.72 (0.00)	- 0.001 RR=0.99 (0.98)	0.02 RR=1.02 (0.19)	- 0.10 RR=0.89 (0.42)	0.57 RR=1.77 (0.01)	- 0.88 RR=0.41 (Sig)	- 0.35 RR=0.70	0.00

Key:- RR = Relative risk: the ratio of the rate of disease among an exposed group compared with a non-exposed group.

Variable Range:

ANAS exposure:
Non-exposed = 0
Exposed group = 1

Birth order: 1-14
Age of mother at pregnancy: 14-46

Smoking during pregnancy :
0 = none
1 = under 20 cigarettes 1 day
2 = over 20 cigarettes 1 day

previous spontaneous abortion :
0 = none
1 = had previous spontaneous abortion.

Occupation:
Doctor OCCN 1 = 1
OCCN 2 = 0
Nurse OCCN 1 = 0
OCCN 2 = 1
Other OCCN 1 = 0
OCCN 2 = 0

Model #1: Female expposed vs female non-exposed
Model #2: Female random sample vs female non-exposed
Model #3: Male exposed vs male non-exposed
Model #4: Male random sample vs male non-exposed

TABLE 19

DISTRIBUTION OF CONGENITAL ABNORMALITIES
AMONG LIVE BIRTHS BY EXPOSURE AND OCCUPATION GROUPS

SEX OF RESPONDENT	EXPOSURE GROUP	OCCUPATION GROUP	REPORTED CONGENITAL ABNORMALITY	REPORTED NO CONGENITAL ABNORMILITY	TOTAL
Female	Non-Exposed	Doctor	2	98	100
		Nurse	71	847	918
		Other	55	717	772
		Sub-total	128	1662	1790
			(7.2%)	(92.8%)	(100%)
	Exposed	Doctor	38	262	300
		Nurse	389	2943	3332
		Other	21	167	188
		Sub-total	448	3372	3820
			(11.7%)	(88.3%)	(100%)
	Randon Sample	Doctor	3	54	57
		Nurse	79	528	607
		Other	1	33	34
		Sub-total	83	615	698
			(11.9%)	(88.1%)	(100%)
Male	Non-Exposed	Doctor	34	865	899
		Nurse	2	43	45
		Other	15	416	431
		Sub-total	51	1324	1375
			(3.7%)	(96.3%)	(100%)
	Exposed	Doctor	240	4363	4603
		Nurse	10	107	117
		Other	11	147	158
		Sub-total	261	4617	4878
			(1.3%)	(94.7%)	(100%)
	Random Sample	Doctor	58	1105	1163
		Nurse	1	26	27
		Other	3	28	31
		Sub-total	62	1159	1221
			(5.1%)	(94.9%)	(100%)
Unknown Sex	Non-Exposed	Doctor	-	3	3
		Nurse	2	1	3
		Other	-	3	3
		Sub-total	2	7	9
			(22.2%)	(77.8%)	(100%)
	Exposed	Doctor	2	5	7
			(28.6%)	(71.8%)	(100%)
TOTAL			892	10987	11879
			(7.5%)	(92.5%)	(100%)

TABLE 20

CONGENITAL ABNORMALITY RATES*
FOR CHILDREN OF EXPOSED AND NON-EXPOSED

FEMALE RESPONDENTS

OCCUPATION	EXPOSED	NON-EXPOSED	SIGNIFICANCE
DOCTORS	13.1±2.1 (300)	3.0±2.1 (96)	P 0.05
NURSES	10.9±0.7 (3309)	6.6±1.1 (915)	P 0.05
OTHERS	12.0±3.1 (185)	6.4±1.3 (772)	N.S.

MALE RESPONDENTS

OCCUPATION	EXPOSED	NON-EXPOSED	SIGNIFICANCE
DOCTORS	5.5±0.4 (4272)	5.0±0.9 (817)	N.S.
NURSES	5.9±2.1 (114)	4.4±3.1 (45)	N.S.
OTHERS	4.9±1.5 (152)	4.1±1.3 (430)	N.S.

*Standardized congenital abanormality rates, per 100 live-born babies, with standard errors and number of live-born babies per group in parentheses.

TABLE 21

LOGISTIC REGRESSION EQUATIONS FOR THE EFFECT OF ANAESTHETICS ON CONGENITAL ABNORMALITIES

MODEL #	INTERCEPT	ANAESTHETICS EXPOSURE	AGE OF BIRTH ORDER	SMOKING MOTHER AT PREGNANCY	DURING PREGNANCY	OCCN 1	OCCN 2	P-VALUE
1	- 1.42	0.64 RR=1.91 (0.00)	0.08 RR=1.08 (0.02)	- 0.05 RR=0.94 (0.00)	0.03 RR=1.03 (0.63)	0.16 RR=1.18 (N.S.)	0.05 RR=1.06	0.00
2	- 1.08	0.71 RR=2.04 (0.00)	0.16 RR=1.18 (0.004)	- 0.07 RR=0.92 (0.0001)	0.20 RR=1.22 (0.08)	- 0.67 RR=0.50 (N.S.)	0.22 RR=1.21	0.00
3	- 3.84	0.38 RR=1.46 (0.03)	- 0.02 RR=0.97 (0.50)	0.02 RR=1.02 (0.13)	0.27 RR=1.31 (0.002)	- 0.10 RR=0.90 (N.S.)	0.25 RR=1.29	0.005
4	- 4.79	0.27 RR=1.31 (0.21)	0.01 RR=1.01 (0.76)	0.05 RR=1.05 (0.03)	0.29 RR=1.34 (0.05)	- 0.09 RR=0.91 (N.S.)	- 0.08 RR=0.91	0.02

Variable Range:

ANAS exposure: Non-exposed = 0
Exposed group = 1
Birth order: 1-14
Age of mother at pregnancy: 14-47

Occupation Goup:
Doctor OCCN 1 = 1, OCCN 2 = 0
Nurse OCCN 1 = 0, OCCN 2 = 1
Other OCCN 1 = 0, OCCN 2 = 0

Smoking during pregnancy :
0 = none
1 = under 20 cigarettes 1 day
2 = over 20 cigarettes 1 day

Model #1 : Female exposed vs non-exposed
Model #2 : Female random sample vs non-exposed
Model #3 : Male exposed vs non-exposed
Model #4 : Male random sample vs non-exposed.

Key:- RR = relative risk (odds ratio)

TABLE 22

DISTRIBUTION OF CANCER IN CHILD

SEX OF RESPONDENT	EXPOSURE GROUP	OCCUPATION GROUP	REPORTED CANCER	REPORTED NO CANCER	NOT RESPONDED TO WHETHER CANCER OCCURRED	TOTAL
Female	Non-exposed	Doctor	-	86	14	100
		Nurse	1	873	44	918
		Other	-	744	28	772
		Sub-total	1	1703	86	1790
			(0.1%)	(95.1%)	(4.8%)	(100%)
	Exposed	Doctor	2	279	19	300
		Nurse	7	3129	196	3332
		Other	1	180	7	188
		Sub-total	10	3588	222	3820
			(0.3%)	(93.9%)	(5.8%)	(100%)
	Random Sample	Doctor	-	53	4	57
		Nurse	-	539	68	607
		Other	-	31	3	34
		Sub-total	-	623	75	698
				(89.3%)	(10.7%)	(100%)
Male	Non-exposed	Doctor	-	736	163	899
		Nurse	-	44	1	45
		Other	1	411	19	431
		Sub-total	1	1191	183	1375
			(0.1%)	(86.6%)	(13.3%)	(100%)
	Exposed	Doctor	11	4001	591	4603
		Nurse	-	113	4	117
		Other	-	138	20	158
		Sub-total	11	4252	615	4878
			(0.2%)	(87.2%)	(12.6%)	(100%)
	Random Sample	Doctor	3	929	231	1163
		Nurse	-	26	1	27
		Other	-	23	8	31
		Sub-total	3	978	240	1221
			(0.2%)	(80.1%)	(19.7%)	(100%)
Unknown Sex	Non-exposed	Doctor	1	2	-	3
		Nurse	-	3	-	3
		Other	-	3	-	3
		Sub-total	1	8	-	9
			(11.1%)	(88.9%)	-	(100%)
	Exposed	Doctor	-	7	-	7
				(100%)		(100%)
TOTAL			24	10749	1106	11879
			(0.2%)	(90.5%)	(9.3%)	(100%)

TABLE 23

COMPARISON OF CHARACTERISTICS OF ASA AD HOC COMMITTEE STUDY AND OHB SURVEY STUDY

Study:	AD HOC Committee 1974	OHB Survey 1987
Dates of Data Collection:	1974	1981-1985
Location:	United States	Ontario, Canada
Groups Compared:	Operating room personnel VS. non-operation room professionals	Workers exposed to anaesthetics vs non-exposed
Method of Data Collection:	Mail questionnaire	Interview, self-administered and a combination of both
Sample Size:	29,810 exposed 10,234 unexposed	6336 exposed 2202 non-exposed
Response Rate:	60.1% exposed 42.8% unexposed 54.5% overall	78.8% exposed 87.2% non-exposed 80.8% overall
Outcomes of Interest:	Spontaneous abortions Congenital abnormalities Malignancies Hepatic disease Renal disease	Spontaneous abortions Congenital abnormalities Cancer/leukemia Liver disease Kidney/urinary tract disease
Confounding variables:	Age Cigarettee smoking X-ray exposure Pregnancy history	Age Cigarettee smoking Drinking habit Pregnancy history

HYGIENE SURVEY - RESULTS AND DISCUSSION:

B. Hygiene Survey

1. Number of Rooms Surveyed

The total number of rooms where anesthetic gas exposure could occur was obtained from the hospitals visited. There were 750 such rooms in 74 hospitals, an average of 10.1 rooms per hospital, including 433 operating rooms (an average of 5.9 per hospital), 77 recovery rooms (an average of 1.0 per hospital), 103 delivery rooms (an average of 1.4 per hospital), 49 emergency rooms with facilities to administer inhalation anesthesia (an average of 0.7 per hospital) and 88 other rooms of various types where exposure might occur (an average of 1.2 per hospital).

A total of 433 rooms were investigated and the type/function of the rooms surveyed is shown in Table 1.

2. Surgery Duration Time

An estimate of the average surgery duration-time per patient was determined from data obtained during long-term sampling of halocarbons. The halocarbon sampling duration-times were notably longer than surgical duration-times since 80% of the sampling surveys included more than one, and up to six surgical procedures. Surgical duration-times for 71 surgical procedures varied from 15 to 480 minutes (see Table 2). It will be noted that the median value is 44.2 minutes. When halocarbon sampling duration-times lasted longer than one surgical procedure and the actual length of each procedure was not noted, the surgical duration-time was estimated by equally dividing sampling duration-time among the number of procedures covered regardless of the type of surgical procedure.

3. Type of Anesthesia Administration

In the hospitals surveyed the breathing systems predominantly in use were:

i) Circle Re-breathe (CRB), containing CO_2 absorption facilities and two uni-directional flow valves.

ii) Bain (modified T-piece)

iii) Modified T-piece paediatric.

The number of rooms in which these systems were found is shown in Table 3.

The breathing systems mentioned above varied in the dynamics of fresh gas supply and of the expiratory gas behaviour in terms of dead-space re-breathing, and fresh air dilution.

The mode of waste gas discharge represents one of a number of sources of operating room contamination associated with the anesthesia systems. In this context, the term, waste-gases includes not only patient-exhaled gases but also fresh gas which is discharged from the breathing system without having been utilized by the patient.

Anesthesia administration was by facial mask or by oral or nasal endo-tracheal tube as shown in Table 4.

It is generally assumed that a 50:1 ratio of N_2O: halocarbon is commonly used for anesthesia as standard practice. The survey finding was that the ratio administered varied over a wide range as shown in Tables 5, 6 and 7.

In spite of wide ranges the median values are close to 50 (except for isoflurane) as shown below:

Administered Gases	Median
N_2O: enflurane	48.0
N_2O: halothane	45.5
N_2O: isoflurane	39.3

When controlled patient breathing is required a ventilator was used. Table 8 shows those ventilator makes which were found in 126 rooms during the survey.

The types of scavengers present during this survey were divided almost equally between active and passive as shown in Table 9. In the majority of cases these scavengers were commercially made rather than hospital-devised as shown in Table 10.

4. Air sampling Results

a) By Location

N_2O area samples were taken during the survey from:

- Leak source area samples at the following locations
  - i) exhalation valve (152 samples)
  - ii) high pressure piping (138 samples)
  - ii) mask, endotracheal tube (155 samples).

- The exhaust grille (115 samples).

Table 11 tabulates the concentrations by location. The number of N_2O area samples taken at each location within a room ranged from 3 to 38. Each reading took between 30 and 60 seconds.

It was determined that the average or mean of the raw data would be used as the most likely N_2O concentration prevailing during spot sampling.

The N_2O readings taken with the sampling probe in the approximate area of the workers breathing zone were labelled personal readings and the mean was derived from 4 to 26 readings. A total of 443 N_2O personal air levels were obtained in the survey with a frequency distribution as shown in Table 12.

Table 13 shows the room average N_2O area sampling results for all recovery rooms (RRs). These room averages were calculated by averaging the patient breathing zone samples taken in the RR. In this case the patient breathing zone samples were considered to be emission sources. Table 14 shows the distribution of mean N_2O worker personal air levels taken in RRs.

b) Time-weighted Average Exposures:

In Table 15 the time-weighted average (TWA) exposure of workers in the operating room (OR) is calculated. In this case the TWA exposure to N_2O was calculated using the formula:

$TWA(N_2O)$ = (N_2O mean personal air level x hours exposed to anaesthetics per week) ÷ 40.

The weekly exposure hours for personnel was derived from the health effects questionnaire and the hygiene visits.

Table 16 shows the distribution of personal mean N_2O levels by occupation and sex. Table 17 shows the distribution of N_2O TWA concentrations by occupation and sex.

For the occupation groups with 10 or more workers, the median results from the individual samples are as follows:

Occupation	Personal Level (ppm)	TWA (ppm)
Anesthetist	87.2	65.5
Surgeon, General	58.8	27.4
Scrub Nurse	51.6	33.0
OR Circulating Nurse	35.1	19.9
Staff Nurse	27.8	----

The distribution of weekly exposure to anesthetic gases by occupation (used to calculate TWA's) is shown in Table 18.

The sampling duration-times for the halocarbons (enflurane, halothane, and isoflurane) ranged from 30 minutes to 4 hours. Thus the halocarbon data are more representative of exposure than the mean N_2O direct reading results in that the former are time-weighted, long-term sampling values. On the other hand, the halocarbon data suffer from the weakness that:

i) They are fewer in number.

ii) Accurate estimates of the average duration of exposure to <u>individual</u> halocarbons per week was not feasible.

Five hundred and five halothane personal air samples were obtained and the frequency distribution is shown in Table 19. The sampling duration-times are summarized in Table 20.

Enflurane personal air levels were obtained for 503 workers and the frequency distribution is shown in Table 21. The sampling duration-times for the 503 enflurane personal samples are summarized in Table 22.

One hundred and forty-six isoflurane personal air levels were collected and the frequency distribution is shown in Table 23. The sampling duration-times are shown in Table 24.

Tables 25, 26 and 27 show the TWA exposures for halothane, enflurane and isoflurane.

The data in Tables 28, 29 and 30 shows the distribution of TWA halothane, enflurane and isoflurane by occupation and by sex.

5. Ventilation Measurements:

During the survey, measurements were made to determine the dilution ventilation in the various operating rooms and this was expressed as air changes per hour (AC/hr) (see Table 31).

It was noted during the ventilation survey that the location of the fresh air and return air grilles, or louvres, was an important factor in determining airflow patterns, air velocities and contaminant removal rates.

The hygienist made a judgement of the extent of air mixing within the room from his observation of the positioning of fresh air and return air grilles and expressed it as percent mixing (see Table 32).

6. Nitrous Oxide (N_2O) Correlations

In order to evaluate the importance of the various factors affecting control of the environment the N_2O air sampling results were correlated with many variables including air changes per hour with or without percentage mixing, type of operating room (OR) equipment such as scavenger systems and the use of ventilators.

It was noted during the ventilation survey that the disposition of the fresh-air and return-air grilles, or louvres, is an important factor in determining airflow patterns, air velocities and contaminant removal rates. When mixing is less than 100% it reduces the effectiveness of the dilution provided. Accordingly, an analysis was undertaken to correlate the various air concentrations with air changes per hour with and without adjustment for % mixing factor. The analysis showed that there was no statistical difference with the adjustment for mixing factor.

The mean area air sampling data for N_2O was correlated with the following independent variables:

- o air changes/hour;
- o scavenger make; and
- o location of air sample.

It was shown that the effect of dilution ventilation (air changes/hour) is not significant when compared to the effect of scavenger make and sample location.

A total of 161 of 560 area concentrations were recorded as greater than 1,000 ppm which is the upper limit of the direct reading instruments. Two sets of analyses were therefore performed for the area concentration data. One analysis with all data including those over 1,000 ppm (identified as 1,001 ppm) and the other analysis excluded those above 1,000 ppm.

Both sets of data showed the same trends. That is, the effect of dilution ventilation was not significant when compared to scavenger make and sample location, and there was no correlation between area samples and dilution ventilation. This is probably due to the fact that the majority of area samples were actually point source samples (see Table 11 locations 2, 3 and 4) and thus, were not representative of the environment in the OR.

The analyses showed that for each increase of 1 AC/hr., the overall N_2O area concentration would be reduced by 2.95 ppm and the personal breathing zone by 1.63 ppm. Thus, for a hospital that has 20 air changes per hour, the overall concentration is reduced by about 60 ppm and the personal exposures by 32 ppm (assuming the reduction is linear over the whole range).

A regression analysis was carried out comparing air sampling results (area and personal) when different scavengers were present. The results showed that not all scavengers produced the same control. It was found that one particular make when compared with all other major scavenger makes reduced the point source air concentration by up to 213 ppm and personal exposures up to 96 ppm. In spite of the relationship found between scavenger make and air sampling results, the strength of the association was found to be weak.

The N_2O data gathered was split into the following subsets to determine if different types of operating room equipment and scavengers would result in better control of anesthetic waste gases.

i) by the type of scavenger
   - o active
   - o passive
   - o none present
   - o hospital-devised (home-made)
   - o commercially purchased

ii) by the type of breathing circuit
   - o bain (open)
   - o circuit rebreathe (CRB) (closed)
   - o paediatric

iii) by specific make of scavenger

The analysis of these subsets of data once again illustrated that dilution ventilation as recorded in this study had a minimal effect on overall area concentration even when the results greater than 1,000 ppm were excluded. In addition, correlations between personal samples, exhaust grille samples and dilution ventilation were not found to be statistically significant.

From the preceding analyses it is obvious that the effect of dilution ventilation is less than the effect of scavenger make. However, dilution ventilation in the surgical/medical environment is required to meet other criteria than just waste anesthetic gas removal, e.g. for infection control, positive pressurization, and temperature/humidity control.

The Ontario Ministry of Health recommends 24 air changes/hr. with no recirculation during operations. Our data in Table 31 shows that just under 23% of the ORs surveyed are meeting the air change requirements. This low figure is likely a reflection of the number of hospitals which were built before the Ministry of Health criteria were established.

During the hygiene surveys, it was noted that some hospitals with high ventilation rates, i.e. greater than 24 air changes/hr. also had high N_2O leakage rates and inadequate scavenger performance. The control strategy of using high ventilation in preference to controlling N_2O leakage and providing efficient scavenging was not effective.

It was reasoned that if the surgeon and scrub nurses (or technician) were working on head/neck region surgery their exposures could be higher than for other types of surgery for a number of reasons, e.g. working in close proximity to the anesthetic gas machine, near the face where the anesthetic gas is administered to the patient, poor endotracheal or mask seals permitting increased leakage. However, analysis of the data using a means test comparison showed no significant difference between head/neck surgery and others. This would tend to suggest that the endotracheal tube or facemask may not be the prime source of anesthetic gas exposure. However, since the direct reading monitor had a cutoff at 1,000 ppm, high levels in the head/neck region where the concentration was well above 1,000 could have been underestimated and therefore, a significant difference between head/neck surgery and other surgery may have been missed.

In an attempt to see which factors could contribute to personal exposures, correlations were attempted between personal N_2O levels and the use or lack of use of ventilators since the ventilator is often a source of exhausted N_2O. No significant correlation was obtained.

Since scavengers have been noted in the literature as the most effective way of controlling emissions, an attempt was made to compare personal air levels with the presence or absence of scavenger intakes at pressure relief valves or at ventilators.

The lack of scavenging does not result in a significant difference in personal air concentrations; however, since this is based on only three cases where there were no scavengers present as compared with 305 cases where scavengers were present, the conclusion is not statistically sound. While it would have been interesting to obtain more data in hospitals without scavenging, it would not have been prudent to require hospitals to turn off their scavenging during any part of the sampling. It should be noted, however, that the CSA Standard CAN 3-Z168.8-M82 Anesthetic Gas Scavenger System suggests sampling should be done with the scavenging system disconnected to illustrate to OR staff the dramatically lower concentrations when scavenging is employed and thus, to encourage everyone to employ the scavenging system.

A correlation was made between the mean personal sample readings and exhaust grille readings to determine whether the grille readings could be used as an indicator for personal exposure as suggested in CSA Standard (CAN 3-Z168.8-M82). The ratios for the various occupations mean personal readings when compared with exhaust grille readings is shown in Tables 33 to 37. The following is a summary of this data:

Occupation		Median Value (Mean personal reading/ exhaust grille reading)
i)	all occupations (lumped together)	1.12
ii)	anesthetists	1.41
iii)	scrub nurses	1.00
iv)	circulating nurses	1.00
v)	general surgeons	1.13

From the above, it can be concluded that the exhaust grille readings give a good representation of personal exposures except for the anesthetists. Our data shows that based on the median value the anesthetists personal exposure is 41% higher than the exhaust grille reading. This approach appears to be useful as an indicator for overall personal exposure to N_2O.

A review of the N_2O area air sampling results in Table 11 shows that the leak point sources (such as exhalation valve, N_2O supply piping and mask/endotracheal coupling) are much higher than the exhaust grille readings.

It is of interest to note that all three major sources of leaks show a significant percentage of results above 1,000 ppm as shown in Table 11. This data conclusively demonstrates that all hospitals need to improve both their equipment maintenance and techniques or work practices to ensure that leak sources are contained.

It has been suggested by some respiratory technologists that the major factor leading to high personal exposures in the OR is poor work practices,

rather than equipment leaks as demonstrated by peaks recorded at the exhaust grille when some procedures by the anesthetists were taking place. However, patient safety is of utmost importance and no change in technique can be considered which would compromise this imperative.

A very poor correlation was found between personal exposure and leak source concentrations. One of the reasons for this could be attributed to the manner in which the N_2O samples were taken since both readings were not taken simultaneously. It was also noted by the contract hygienist that due to many factors, the N_2O concentrations in the work areas of the operating staff can change quickly and unpredictably.

7. Recovery Room (RR) Correlations

The layout of the RR, the number of patients in the RR at one time and the depth of anesthesia in the patient may account for the variability of RR exposure. The main source of anesthetic gas contamination in the recovery room is the post-operative patient. Table 13 shows the room average N_2O sampling results for all recovery rooms. These were calculated by averaging the patient breathing zone samples taken in the RR.

Table 14 shows the distribution of mean N_2O personal air levels taken in RRs. The median value was 28.7 ppm. No linear correlation could be established between N_2O personal air level and the average RR N_2O air level. This is not surprising since the data used to compile the room average results came from patient breathing zone levels. The key factor in determining RR worker exposure is the time spent by the nurse near the patient.

8. Halocarbon Correlations

The halocarbon air sampling was used to determine long-term personal exposures to anesthetic gases to determine if the administration ratio correlates with the exposure ratio of these gases and confirm that if N_2O is adequately controlled, halocarbon air levels would be similarly controlled as reported in the literature.

The administration ratio of N_2O: halocarbon is reported in the literature to be 50:1. However, the survey showed different ratios administered as shown in Tables 8, 9 and 10.

In spite of the wide range of results the median values are close to 50:1 except for isoflurane.

A linear model was used to correlate N_2O: halocarbon administered with N_2O personal air level: halocarbon personal air level for each halocarbon--halothane, enflurane and isoflurane sampled in the operating rooms.

No correlation was observed between the ratio of administration rates of gases and their respective ratio of personal air levels. The printout of these correlations is shown in Tables 38, 39 and 40.

Also, a linear model correlating N_2O: halocarbon administration rate with ratio of area air levels N_2O: halocarbon was carried out and no correlation was observed.

Our data supported the assumption that if N_2O is under control halocarbons will also be under control.

No correlation was observed between ventilation rates and halocarbon concentrations in recovery rooms.

There was no significant correlation between halocarbon area or personal air levels with ventilation in the operating rooms. This could be explained by the fact that staff members wearing the halocarbon sampling pumps would frequently change their sampling environment by moving between ORs and other rooms in the OR suite. Thus the TWA exposure data obtained for halocarbons could not be easily evaluated on the same environmental variables (i.e. ventilation) as the spot exposure data for N_2O.

9. Personal Air Levels

Long-term personal results for halocarbons were also used to estimate the exposures of the various exposed groups to anesthetic gases. Nitrous oxide readings with the sampling technique used does not allow accurate estimation of a time-weighted average exposure.

Nitrous oxide sampling was carried out by taking spot readings in a serial fashion in selected "zones". The N_2O concentrations in the work areas of the operating staff can change quickly and unpredictably, and this is reflected in the large variation in personal sampling results. Nevertheless, the range of N_2O concentrations comprising a personal exposure may quite correctly be interpreted as being representative of that person's exposure in a given OR at a specific stage of the surgical procedure involved. However, due to the short sampling duration it may not be appropriate to compare personal air levels with the 40 hr. exposure limit of 25 ppm.

Since the personal samples for N_2O are essentially instantaneous readings it may be appropriate to compare these results with 125 ppm, which is five times the TLV-TWA and may be used to represent an excursion as suggested by the ACGIH. A check of Table 12 would indicate 30.2% of the samples were above 125 ppm.

Table 15 shows the frequency distribution of N_2O time-weighted average exposure. The interpretation of this data must include consideration of the assumptions being made regarding the nature of the extended occupational situation to which the TWA estimate is meant to apply.

The concentration measured during the short-term sampling period is not representative of that worker's exposure for the entire week, since exposure concentrations are known to change for each operation. Thus the exposure will change not only from day-to-day but within each day. In order to overcome these fluctuations full shift sampling for five days would be required. This certainly was not possible during this study due to sampling limitations.

Table 15 shows that the median is 37.6 ppm which means 50% of the results were above this value. In addition approximately 60% of the results are above 25 ppm. This would suggest that N_2O in operating rooms is not under good control.

In looking at the data in Tables 16 and 17 it is seen that the anesthetist has the highest exposure of the major group of occupations surveyed. It is noted that the general surgeons' TWA exposure is much lower than the anesthetist's. The explanation for this is found in the fact that his weekly exposure duration is only 10.5 hours (as shown in Table 18).

It should be noted that this data is consistent with earlier data which correlated personal exposures with exhaust grille readings. Earlier it was shown that the anesthetist had the highest exposure followed by the general surgeon, scrub nurse and OR circulating nurse.

The following summary compares the results with the 2ppm Ontario guideline.

Halocarbon	Personal Level Median (ppm)	% of Personal Samples > 2 ppm	TWA Exposure Median (ppm)	% of TWA Exposure >2 ppm
Halothane (mean sampling time = 135.0 min)	0.01	6.5	0.07	4.12
Enflurane (mean sampling time = 134.9 min)	0.40	19.08	0.20	15.92
Isoflurane (mean sampling time = 132.5 min)	0.60	2.05	0.06	5 (extrapolated)

The individual halocarbon results are shown in Tables 19, 21, 23 and the TWA halocarbon results in Tables 25, 26 and 27.

The halocarbon data indicates that the halothane and isoflurane exposures are controlled in most hospitals while the enflurane is not. While the frequency of TWA exposures exceeding 2 ppm are only 4% and 5% respectively for halothane and

isoflurane the enflurane has 16% of the TWA exposures in excess of 2 ppm. A look at the detailed distribution of halocarbon TWA's by occupation (Tables 28, 29 and 30) shows that when all sexes were considered (male, female, undetermined) the median values are all less than or equal to 0.1 ppm for halothane and generally less than 0.1 ppm for isoflurane (except for general surgeons at 0.20 ppm). However the enflurane values are generally above 0.1 ppm with the housekeeping staff at 1.69 ppm and general surgeons at 6.3 ppm.

The reason why enflurane was not controlled could not be based on its physical properties as shown below which shows that enflurane is the least volatile. Thus, under the same conditions the emission of enflurane into the air would be less than halothane and isoflurane, and it should therefore have been reasonable to assume that with the same control technology enflurane would be controlled to a better extent.

Anesthetic	Boiling Point °C	Vapour Pressure at 20°C (mm Hg)	Concentration of Vapour Delivered By a Saturation Vapourizer at 200°C
Isoflurane	48	252	33%
Halothane	50	243	32%
Enflurane	57	180	24%

Note: Derived from "The Pharmacological Basis of Therapeutics" by Goodman and Gilman.

10-TABLES FOR HYGIENE SURVEY RESULTS

TABLE 1

Frequency Distribution of Hospital Rooms Surveyed

Room Type/Function	Frequency	Percent
General Surgery	143	33.0
Minor Surgery	7	1.6
Major Surgery	3	0.7
Trauma Room	1	0.2
Surgery with Contaminated or infected tissues	1	0.2
Special procedure	1	0.2
Cystoscopy only (Urology)	25	5.8
Urological surgery	7	1.6
Gynaecologic surgery	23	5.3
Paediatric surgery	1	0.2
Otolaryngological surgery	21	4.9
Head and neck surgery	1	0.2
Dental surgery	9	2.1
Eye surgery	8	1.8
Neurosurgery	3	0.7
Orthopaedic surgery	22	5.1
Fracture room	5	1.2
Cast room	7	1.6
Plastic room	6	1.4
Cardiovascular surgery	6	1.4
Open heart surgery	2	0.5
Perivascular surgery	1	0.2
Recovery room	70	16.2

TABLE 1 (cont.)

Frequency Distribution of Hospital Rooms Surveyed

Room Type/Function	Frequency	Percent
Obstetrical surgery, non specific	23	5.3
Obstetrical surgery, caesarian	4	0.9
Emergency room	16	3.7
Housekeeping area/OR suite and reception	1	0.2
Administrative office, OR suite	2	0.5
Hallways/OR suite	6	1.4
Radiological procedures room	5	1.2
Preperation/service area	2	0.5
Electroconvulsive therapy	1	0.2
Total	433	100.0

TABLE 2

Frequency Distribution of Surgical Durations
for which Halocarbon Samplings were Performed

Duration (min.)	Frequency	Percent
15 - 19	2	0.5
20 - 29	46	11.0
30 - 39	97	23.2
40 - 49	87	20.8
50 - 59	48	11.5
60 - 69	68	16.3
70 - 79	15	3.6
80 - 89	14	3.3
90 - 99	8	1.9
100 - 109	8	1.9
110 - 119	1	0.2
120 - 129	9	2.2
130 - 139	2	0.5
140 - 149	2	0.5
150 - 159	2	0.5
160 - 480	9	2.2
Total	418	100.0
mean (min.)	54.8	
S.D.	40.4	
median	44.2	

TABLE 3

Breathing Circuit

Breathing Circuit	# of Rooms
Bain	108
Circuit rebreathe (closed)	65
Modified T-piece (paediatric)	10

TABLE 4

Endo-tracheal Tube or Mask Administration

Administration Type	# of ORs
Endo-tracheal tube	82
Endo-tracheal tube (un-cuffed)	1
Nasal intubation	3
Mask	28

TABLE 5

Frequency Distribution of N_2O:Halothane Administration Rate

Rate	Frequency	Percent
less than 20.0	2	3.1
20.0 - 29.9	12	18.4
30.0 - 39.9	15	23.1
40.0 - 49.9	6	9.2
50.0 - 59.9	5	7.7
60.0 - 69.9	15	23.1
70.0 - 79.9	0	0.0
80.0 - 89.9	2	3.1
90.0 +	8	12.3
Total	65	100.0
mean	54.1	
S.D.	32.1	
median	45.5	

TABLE 6

Frequency Distribution of N_2O:Enflurane Administration Rate

Rate	Frequency	Percent
less than 20.0	8	13.1
20.0 - 29.9	8	13.1
30.0 - 39.9	13	21.3
40.0 - 49.9	2	3.3
50.0 - 59.9	7	11.5
60.0 - 69.9	5	8.2
70.0 - 79.9	1	1.7
80.0 - 89.9	6	9.8
90.0 +	11	18.0
Total	61	100.0
mean	59.3	
S.D.	45.2	
median	48.0	

TABLE 7

Frequency Distribution of N_2O:Isoflurane Administration Rate

Rate	Frequency	Percent
less than 20.0	1	5.6
20.0 - 29.9	1	5.6
30.0 - 39.9	7	38.8
40.0 - 49.9	4	22.2
50.0 - 59.9	1	5.6
60.0 +	4	22.2
Total	18	100.0
mean	48.5	
S.D.	27.4	
median	39.3	

TABLE 8

Ventilator Makes

Make
Airco
Bennet
Narev-Airshield
Ventimeter
Fraser-Harlake (no model specified)
Fraser-Harlake, 701
Narco-Med, Draeger
Ohio (no model specified)
Ohio "Fluidic"
Ohio, Model V5
Medishield, Model 300
Vent-Viva (CIG)
Draeger

TABLE 9

Scavenger Type

Type	# of Rooms
Active (vacuum) scavenger present	128
Passive (no vacuum) scavenger present	147
VV (optional)	3
None	5

TABLE 10

Scavenger Make

Make	# of Rooms
Commercially made scavengers	130
Hospital-devised scavengers	46
Hybrid hospital-devised and Medishield equipment	2

TABLE 11

Distribution of Area N_2O Sample Readings by Location

Area Concentration (ppm)	Location 1		Location 2		Location 3		Location 4	
	#	%	#	%	#	%	#	%
1-100	86	75	27	18	31	22	28	18
101-200	12	10	12	8	23	17	22	14
201-300	9	8	15	9	16	12	11	7
301-400	2	2	7	5	14	10	12	7
401-500	—	—	7	5	3	2	5	3
501-600	—	—	5	3	2	1	8	5
601-700	1	1	8	5	4	3	1	1
701-800	2	2	2	1	2	1	7	4
801-900	—	—	3	2	2	1	4	3
901-1,000	—	—	3	2	--	—	3	2
1,000	3	2	63	41	41	30	54	35
TOTAL	115	100	152	99	138	99	155	99
Mean	110 ppm		595 ppm		460 ppm		545 ppm	
Median	38 ppm		660 ppm		292 ppm		475 ppm	

Note: Location 1 - at exhaust grille
Location 2 - at or near exhalation valve(s)
Location 3 - (high pressure) nitrous oxide piping connections
Location 4 - near breathing circuit patient seal (mask or endotracheal tube)

TABLE 12

Frequency Distribution of Mean N_2O Personal Sampling Results

Sampling Results (ppm)	Frequency	Percent
less than or equal to 25.0	123	27.8
25.1 - 50.0	97	21.9
50.1 - 75.0	49	11.1
75.1 - 100.0	19	4.3
100.1 - 125.0	21	4.7
125.1 - 150.0	14	3.1
150.1 - 175.0	17	3.8
175.1 - 200.0	16	3.6
200.1 - 225.0	11	2.5
225.1 - 250.0	15	3.4
250.1 - 275.0	11	2.5
275.1 - 300.0	6	1.4
300.1 - 325.0	5	1.1
325.1 - 350.0	6	1.4
350.1 - 375.0	1	0.2
375.1 - 400.0	9	2.0
400.1 +	23	5.2
Total	443	100.0
mean (ppm)	115.3	
S.D.	146.3	
median	50.1	
geometric mean	56.1	

TABLE 13

Frequency Distribution of Room Average N_2O Area Sampling Results for all Recovery Rooms

Room Average (ppm)	# of Rooms	Percent
7.0 - 25.0	1	1.5
25.1 - 50.0	1	1.5
50.1 - 75.0	2	2.9
75.1 - 100.0	0	0.0
100.1 - 125.0	2	2.9
125.1 - 150.0	2	2.9
151.1 - 175.0	3	4.4
175.1 - 200.0	2	2.9
200.1 - 300.0	8	17.3
300.1 - 400.0	6	8.8
400.1 - 500.0	6	8.8
500.1 - 600.0	9	13.2
600.1 - 700.0	5	7.4
700.1 - 800.0	4	5.9
800.1 - 900.0	1	1.5
900.1 -1000.0	1	1.5
1000.1 +	14	20.6
Total	68	100.0
mean (ppm)	526.8	
S.D.	319.4	
median	513.0	

TABLE 14

Frequency Distribution of Mean N_2O Personal Air Levels Taken in the Recovery Rooms

Sampling Results (ppm)	Frequency	Percent
less than or equal to 25.0	24	40.0
25.1 - 50.0	27	45.0
50.1 - 75.0	6	10.0
75.1 - 100.0	0	0.0
100.1 - 125.0	1	1.7
125.1 +	2	3.3
Total	60	100.0
mean (ppm)	36.3	
S.D.	42.2	
median	28.7	
geometric mean	26.0	

TABLE 15

Frequency Distribution of N_2O Time-Weighted Average Exposure

N_2O TWA (ppm)	# of Workers
0.75 - 10.0	79
10.1 - 20.0	53
20.1 - 30.0	39
30.1 - 40.0	29
40.1 - 50.0	22
50.1 - 100.0	61
100.1 - 150.0	31
150.1 - 200.0	21
200.1 - 250.0	19
250.1 - 300.0	9
300.1 - 350.0	7
350.1 - 400.0	3
400.1 - 450.0	5
450.1 - 500.0	2
500.1 - 600.0	3
600.1 - 790.6	3
TOTAL	386
Mean (ppm)	86.3
S.D.	118.5
Median	37.6

* Occupation - average weekly hours exposure to anaesthetics was used if such data was not given.

TABLE 16

Distribution of Mean N_2O Personal Air Levels by Occupation and by Sex

Occupation	Sex	# of Workers	N_2O Personal Air Level (ppm) Min.	Max.	Mean	S.D.	Median
Anesthetist	Unknown	14	17.2	910.0	198.1	255.3	84.4
"	F	11	8.6	328.6	118.0	116.7	85.0
"	M	124	2.0	750.0	157.0	168.3	87.3
"	All	149	2.0	910.0	158.0	174.5	87.2
Scrub Nurse	Unknown	42	6.4	668.8	112.4	134.8	56.9
"	F	52	2.0	431.4	91.5	102.0	35.9
"	M	1	241.4	241.4	241.4	—	241.4
"	All	95	2.0	668.8	102.4	117.8	51.6
O.R. Technician	F	5	17.4	633.5	247.3	230.3	181.4
"	M	1	65.0	65.0	65.0	—	65.0
"	All	6	17.4	633.5	217.0	219.0	177.2
O.R. Circulating Nurse	Unknown	1	52.2	52.2	52.2	—	52.2
"	F	43	4.0	450.0	74.9	94.7	36.3
"	M	2	18.4	19.9	19.2	1.1	19.2
"	All	46	4.0	450.0	72.0	92.3	35.1
Nursing Aide/Orderly	M	1	12.0	12.0	12.0	—	12.0
Staff Nurse	Unknown	3	6.8	35.0	23.8	15.0	29.6
"	F	54	4.5	300.0	36.7	44.2	27.7
"	All	57	4.5	300.0	36.1	43.2	27.8
Surgeon, General	Unknown	22	6.4	668.8	143.3	164.9	73.9
"	M	34	2.0	711.1	123.6	167.5	53.9
"	All	56	2.0	711.1	131.4	165.3	58.8
Obstetrician-Gynaecologist	Unknown	4	22.5	248.9	131.0	124.4	126.3
"	F	1	42.0	42.0	42.0	—	42.0
"	M	8	15.7	386.4	154.7	139.1	136.7
"	All	13	15.7	386.4	138.7	127.0	92.0
Orthopaedic Surgeon	M	7	6.8	186.7	61.1	57.9	50.1
Ophthalmologist	Unknown	1	22.5	22.5	22.5	—	22.5
"	M	2	22.8	65.0	43.9	29.8	43.9
"	All	3	22.5	65.0	36.8	24.5	22.8
Otolaryngologist	M	3	26.3	387.5	157.9	199.5	60.0
Urologist	M	1	510.0	510.0	510.0	—	510.0
Housekeeping	F	1	2.0	2.0	2.0	—	2.0
G.P.	M	2	25.3	42.3	33.8	12.0	33.8
Dentist	M	3	15.4	344.4	131.6	184.6	35.0

TABLE 17

Distribution of N_2O TWAs by Occupation and by Sex

Occupation	Sex	# of Workers	N_2O TWA (ppm) Min.	Max.	Mean	S.D.	Median
Anesthetist	Unknown	8	17.5	147.5	63.4	40.5	55.9
"	F	9	7.5	330.6	110.7	121.3	78.6
"	M	91	2.5	790.6	120.7	149.5	63.8
"	All	108	2.5	790.6	115.6	142.2	65.5
Scrub Nurse	F	41	1.9	404.4	74.9	88.4	33.0
O.R. Technician	F	5	12.0	554.3	228.1	199.7	172.9
"	M	1	48.8	48.8	48.8	---	48.8
"	All	6	12.0	554.3	198.2	193.1	171.5
O.R. Circulating Nurse	F	39	0.8	421.9	67.3	96.1	87.8
"	M	2	17.3	19.9	18.6	1.9	18.6
"	All	41	0.8	421.9	65.0	94.3	19.9
Orderly	M	1	7.5	7.5	7.5	---	7.5
Surgeon, General	Unknown	1	4.4	4.4	4.4	---	4.4
"	M	23	0.9	355.6	60.8	93.8	27.7
"	All	24	0.9	355.6	58.4	92.4	27.4
Obstetrician-Gynaecologist	Unknown	2	4.9	57.0	30.9	36.8	30.9
"	F	1	5.2	5.2	5.2	---	5.2
"	M	6	4.6	74.7	23.3	26.5	15.9
"	All	9	4.6	74.7	23.0	25.8	9.2
Orthopaedic Surgeon	M	4	2.5	42.0	14.7	18.4	7.2
Ophthalmologist	Unknown	1	6.7	6.7	6.7	---	6.7
"	M	2	2.8	14.6	8.7	8.3	8.7
"	All	3	2.8	14.6	8.1	6.0	6.7
Otolaryngologist	M	3	3.9	145.3	51.7	81.0	6.0
Housekeeping	F	1	1.8	1.8	1.8	---	1.8
G.P.	M	1	8.5	8.5	8.5	---	8.5
Dentist	M	2	4.4	15.4	9.9	7.8	9.9

TABLE 18

Distribution of Weekly Exposure to Anesthetic Gases by Occupations

Occupation	# of Workers	Hours Exposure per Week				
		Min.	Max.	Mean	S.D.	Median
Anesthetist	119	3	65	33.2	17.0	37.5
Scrub Nurse	55	3	40	31.4	10.2	37.5
O.R. Technician	16	27.5	40	37.2	3.5	38.7
O.R. Circulating Nurse	132	3	40	34.1	8.6	37.5
Orderly	17	25	40	36.8	3.4	37.5
Surgeon, General	26	3	20.7	12.8	6.2	10.5
Obstetrician-Gynaecologist	11	5	20	11.2	5.0	10.0
Neurosurgeon	1	42	42	42.0	—	42.0
Orthopaedic Surgeon	4	2	9	6.5	3.1	7.5
Ophthalmologist	3	5	12	8.7	3.5	9.0
Otolaryngologist	4	4	30	13.7	11.8	10.5
Urologist	2	21	27	24.0	4.2	24.0
Housekeeping	6	37	37.5	37.4	0.2	37.5
G.P.	4	5	16.5	10.4	5.0	10.0
Biomedical Technician	1	40	40	40.0	—	40.0
Dentist	4	2	40	12.7	18.2	4.5
Hospital Technician	1	37.5	37.5	37.5	—	37.5

TABLE 19

Frequency Distribution of Halothane Personal Air Levels

Halothane Personal Air Level (ppm)	# of Workers
0.03 - 0.05	186
0.06 - 0.10	96
0.10 - 0.20	40
0.21 - 0.30	36
0.31 - 0.50	34
0.51 - 1.00	39
1.01 - 2.00	41
2.01 - 5.00	22
5.01 - 10.00	6
10.00	5
TOTAL	505
Mean (ppm)	0.9
S.D.	5.6
Median	0.1

TABLE 20

Frequency Distribution of Halothane Personal Air Sampling Duration

Halothane Personal Air Sampling Duration (min.)	# of Samples
15 - 50	6
60 - 100	70
105 - 150	296
155 - 200	110
210 - 240	23
TOTAL	505
Mean (minutes)	135.0
S.D.	37.7
Median	130.0

TABLE 21

Frequency Distribution of Enflurane Personal Air Levels

Enflurane Personal Air Level (ppm)	# of Workers
0.01 - 0.1	212
0.11 - 0.2	17
0.21 - 0.3	20
0.31 - 0.4	22
0.41 - 0.5	12
0.51 - 1.0	61
1.1 - 2.0	63
2.1 - 3.0	26
3.1 - 4.0	16
4.1 - 10.0	36
10.1 - 21.3	18
TOTAL	503
Mean (ppm)	1.6
S.D.	3.2
Median	0.4

TABLE 22

Distribution of Enflurane Personal Air Sampling Duration

Enflurane Personal Air Sampling Duration (min.)	# of Samples
15 - 50	6
60 - 100	71
105 - 150	291
155 - 200	112
210 - 240	23
TOTAL	503
Mean (minutes)	134.9
S.D.	37.8
Median	130

TABLE 23

Frequency Distribution of Isoflurane Personal Air Levels

Isoflurane Personal Air Level (ppm)	# of Samples
0.03 - 0.05	71
0.06 - 0.1	14
0.11 - 0.5	28
0.6 - 1.0	16
1.01 - 2.0	14
2.1 - 8.1	3
TOTAL	146
Mean (ppm)	0.4
S.D.	0.9
Median	0.06

TABLE 24

Distribution of Isoflurane Personal Air Sampling Duration

Isoflurane Personal Air Sampling Duration (min.)	# of Samples
60 - 100	21
105 - 150	93
160 - 200	25
210 - 225	7
TOTAL	146
Mean (minutes)	132.5
S.D.	35.6
Median	122.5

TABLE 25

Frequency Distribution of Halothane Time-Weighted Average Exposure

Halothane TWA (ppm)	# of Workers
0.005 - 0.02	33
0.0201 - 0.04	68
0.0401 - 0.06	70
0.0601 - 0.1	43
0.101 - 0.2	42
0.201 - 0.3	26
0.301 - 0.5	16
0.51 - 1.0	25
1.01 - 2.0	26
2.1 - 10.0	11
10.0	4
TOTAL	364
Mean (ppm)	0.9
S.D.	6.5
Median	0.07

TABLE 26

Frequency Distribution of Enflurane Time-Weighted Average Exposure

Enflurane TWA (ppm)	# of Workers
0.004 - 0.02	27
0.0201 - 0.04	43
0.0401 - 0.06	62
0.0601 - 0.1	28
0.101 - 0.2	26
0.201 - 0.3	14
0.301 - 0.5	22
0.501 - 1.0	38
1.01 - 2.0	41
2.01 - 10.0	47
10.0	10
TOTAL	358
Mean (ppm)	1.3
S.D.	2.9
Median	0.2

TABLE 27

Frequency Distribution of Isoflurane Time-Weighted Average Exposure

Isoflurane TWA (ppm)	# of Workers
0.005 - 0.02	5
0.021 - 0.04	11
0.041 - 0.06	32
0.061 - 0.1	9
0.11 - 0.2	10
0.21 - 0.3	11
0.31 - 0.5	4
0.51 - 1.0	13
1.1 - 4.05	10
TOTAL	105
Mean (ppm)	0.3
S.D.	0.6
Median	0.06

TABLE 28

Distribution of Halothane TWAs by Occupation and by Sex

Occupation	Sex	# of Workers	Halothane TWA (ppm) Min.	Max.	Mean	S.D.	Median
Anesthetist	Unknown	8	0.01	0.7	0.2	0.2	0.07
"	F	9	0.015	1.0	0.3	0.4	0.15
"	M	89	0.005	93.7	2.8	13.0	0.1
"	All	106	0.005	93.7	2.4	11.9	0.1
Scrub Nurse	F	43	0.02	2.6	0.3	0.5	0.06
"	M	2	0.3	1.0	0.6	0.5	0.6
	All	45	0.02	2.6	0.3	0.5	0.06
O.R. Technician	F	5	0.03	2.6	0.8	1.1	0.07
	M	10	0.04	1.08	0.6	0.5	0.6
	All	15	0.03	2.6	0.7	0.7	0.1
O.R. Circulating Nurse	Unknown	2	0.06	0.5	0.3	0.3	0.3
"	F	115	0.01	5.6	0.3	0.7	0.07
"	M	5	0.03	1.5	0.5	0.6	0.3
"	All	122	0.01	5.6	0.3	0.7	0.08
Orderly	M	17	0.04	0.3	0.07	0.08	0.04
Surgeon, General	Unknown	I	0.04	0.04	0.04	---	0.04
"	M	19	0.01	0.75	0.09	0.2	0.02
"	All	20	0.01	0.75	0.08	0.2	0.02
Obstetrician-Gynaecologist	Unknown	2	0.01	0.01	0.01	0.0	0.01
"	F	1	0.04	0.04	0.04	---	0.04
"	M	8	0.009	0.2	0.05	0.05	0.02
"	All	11	0.009	0.2	0.04	0.05	0.02
Orthopaedic Surgeon	M	4	0.01	0.4	0.1	0.2	0.09
Ophthalmologist	Unknown	1	0.03	0.03	0.03	---	0.03
"	M	2	0.005	0.07	0.04	0.04	0.04
"	All	3	0.005	0.07	0.03	0.03	0.03
Otolaryngologist	M	4	0.03	0.5	0.2	0.2	0.1
Urologist	M	2	0.2	0.3	0.2	0.07	0.2
Housekeeping	F	2	0.04	0.04	0.04	0.0	0.04
"	M	4	0.09	0.7	0.2	0.3	0.09
"	All	6	0.04	0.7	0.2	0.2	0.09
G.P.	M	4	0.006	0.86	0.3	0.4	0.2
Biomedical Technician	M	1	0.1	0.1	0.1	---	0.1

TABLE 28

Distribution of Halothane TWAs by Occupation and by Sex (continued)

Occupation	Sex	# of Workers	Halothane TWA (ppm) Min.	Max.	Mean	S.D.	Median
Dentist	Unknown	1	0.4	0.4	0.4	—	0.4
"	M	2	0.1	2.3	1.2	1.5	1.2
"	All	3	0.1	2.3	0.9	1.2	0.4
Hospital Technician	F	1	0.05	0.05	0.05	—	0.05

TABLE 29

Distribution of Enflurane TWAs by Occupation and by Sex

Occupation	Sex	# of Workers	Enflurane TWA (ppm) Min.	Max.	Mean	S.D.	Median
Anesthetist	Unknown	8	0.04	0.3	0.08	0.09	0.06
"	F	7	0.01	6.2	1.0	2.3	0.1
"	M	91	0.004	13.6	1.4	2.5	0.5
"	All	106	0.004	13.6	1.3	2.4	0.3
Scrub Nurse	F	44	0.01	8.5	1.3	2.0	0.5
"	M	2	0.5	1.9	1.2	1.0	1.2
	All	46	0.01	8.5	1.3	2.0	0.5
O.R. Technician	F	6	0.05	3.5	0.8	1.3	0.4
	M	9	6.3	18.6	13.1	6.4	18.4
	All	15	0.05	18.6	8.2	7.9	6.3
O.R. Circulating Nurse	Unknown	2	0.05	3.2	1.6	2.3	1.6
"	F	114	0.01	11.9	1.0	2.0	0.2
"	M	5	0.03	3.0	0.9	1.3	0.08
"	All	121	0.01	11.9	1.0	2.0	0.2
Orderly	M	16	0.04	0.2	0.05	0.04	0.04
Surgeon, General	Unknown	1	0.01	0.01	0.01	—	0.01
"	M	18	0.01	6.3	0.9	1.6	0.24
"	All	19	0.01	6.3	0.8	1.6	0.2
Obstetrician-Gynaecologist	Unknown	2	0.01	0.03	0.02	0.01	0.02
"	F	1	0.005	0.005	0.005	—	0.005
"	M	8	0.01	0.58	0.2	0.2	0.13
"	All	11	0.005	0.58	0.1	0.2	0.09
Neurosurgeon	M	1	0.1	0.1	0.1	—	0.1
Orthopaedic Surgeon	M	3	0.06	0.56	0.3	0.3	0.2
Ophthalmologist	Unknown	1	0.03	0.03	0.03	—	0.03
"	M	1	0.005	0.005	0.005	—	0.005
"	All	2	0.005	0.03	0.02	0.02	0.02
Otolaryngologist	M	3	0.009	0.4	0.2	0.2	0.23
Urologist	M	2	0.03	0.03	0.03	0.0	0.03
Housekeeping	F	1	0.04	0.04	0.04	—	0.04
"	M	4	0.05	1.69	1.28	0.8	1.69
"	All	5	0.04	1.69	1.0	0.9	1.69
G.P.	M	4	0.006	2.1	0.5	1.0	0.03

TABLE 29

Distribution of Enflurane TWAs by Occupation and by Sex (continued)

Occupation	Sex	# of Workers	Enflurane TWA (ppm) Min.	Max.	Mean	S.D.	Median
Biomedical Technician	M	1	0.1	0.1	0.1	—	0.1
Dentist	M	2	0.005	1.2	0.6	0.8	0.6

TABLE 30

Distribution of Isoflurane TWAs by Occupation and by Sex

Occupation	Sex	# of Workers	Isoflurane TWA (ppm) Min.	Max.	Mean	S.D.	Median
Anesthetist	Unknown	4	0.04	0.06	0.05	0.01	0.06
"	F	2	0.04	1.35	0.7	0.9	0.7
"	M	28	0.01	2.8	0.5	0.7	0.2
"	All	34	0.01	2.8	0.4	0.6	0.07
Scrub Nurse	F	12	0.04	1.1	0.4	0.4	0.03
O.R. Technician	F	1	0.07	0.07	0.07	---	0.07
O.R. Circulating Nurse	Unknown	1	0.05	0.05	0.05	---	0.05
"	F	35	0.03	4.05	0.3	0.7	0.07
"	M	1	0.03	0.03	0.03	---	0.03
"	All	37	0.03	4.05	0.3	0.7	0.05
Orderly	M	10	0.04	0.66	0.23	0.3	0.05
Surgeon, General	M	4	0.02	0.28	0.17	0.16	0.2
Obstetrician-Gynaecologist	M	1	0.17	0.17	0.17	---	0.17
Orthopaedic Surgeon	M	2	0.01	0.01	0.01	0.0	0.01
Ophthalmologist	M	1	0.005	0.005	0.005	---	0.005
Housekeeping	F	1	0.9	0.9	0.9	---	0.9
Dentist	M	2	0.16	1.3	0.7	0.8	0.7

Table 31

Ventilation Rate

Ventilation Rate (Air Changes Per Hour)	Frequency	Per Cent
less than 6	39	14.4
6 - 11.9	54	19.9
12 - 17.9	83	30.6
18 - 23.9	34	12.5
24 - 29.9	25	9.2
30 - 35.9	14	5.2
36 - 41.9	10	3.7
42 - 47.9	6	2.2
48 - 53.9	0	0.0
54 - 59.9	0	0.0
60 - 65.9	1	0.4
66 - 71.9	1	0.4
72 and over	4	1.5
TOTAL	271	100.0
Median	14.3	

Table 32

Percent Mixing

% Mixing	# of Rooms
40	1
50	5
60	17
70	13
80	23
90	53
100	113

TABLE 33

Frequency Distribution of Ratio of Mean N_2O Personal Air Level to Mean N_2O Exhaust Grille Area Air Level for All Occupations

Ratio of mean N_2O personal air level to mean N_2O exhaust grille air level	Frequency	Percent
less than 0.50	26	9.9
0.50 - 0.99	76	29.0
1.00 - 1.49	76	29.0
1.50 - 1.99	36	13.8
2.00 - 2.49	10	3.8
2.50 - 2.99	9	3.4
3.00 - 3.49	9	3.4
3.50 - 3.99	2	0.8
4.00 +	18	6.9
Total	262	100.0
median	1.12	

TABLE 34

Frequency Distribution of Ratio of Mean N_2O Personal Air Level to Mean N_2O Exhaust Grille Area Air Level for Anesthetists

Ratio of mean N_2O personal air level to mean N_2O exhaust grill air level	Frequency	Percent
less than 0.50	8	8.0
0.50 - 0.99	23	23.0
1.00 - 1.49	23	23.0
1.50 - 1.99	17	17.0
2.00 - 2.49	6	6.0
2.50 - 2.99	4	4.0
3.00 - 3.49	6	6.0
3.50 - 3.99	0	0.0
4.00 +	13	13.0
Total	100	100.0
median	1.41	

TABLE 35

Frequency Distribution of Ratio of Mean N_2O Personal Air Level to Mean N_2O Exhaust Grille Area Air Level for OR Scrub Nurses

Ratio of mean N_2O personal air level to mean N_2O exhaust grille level	Frequency	Percent
less than 0.50	7	11.5
0.50 - 0.99	20	32.8
1.00 - 1.49	21	34.5
1.50 - 1.99	8	13.1
2.00 - 2.49	0	0.0
2.50 - 2.99	2	3.3
3.00 - 3.49	1	1.6
3.50 - 3.99	1	1.6
4.00 +	1	1.6
Total	61	100.0
median	1.00	

TABLE 36

Frequency Distribution of Ratio of Mean N_2O Personal Air Level to Mean N_2O Exhaust Grille Area Air Level for OR Circulating Nurses

Ratio of Mean N_2O personal air level to mean N_2O exhaust grille level	Frequency	Percent
less than 0.50	5	13.1
0.50 - 0.99	11	28.9
1.00 - 1.49	15	39.5
1.50 - 1.99	2	5.3
2.00 - 2.49	2	5.3
2.50 - 2.99	1	2.6
3.00 - 3.49	0	0.0
3.50 - 3.99	0	0.0
4.00 +	2	5.3
Total	38	100.0
median	1.00	

TABLE 37

Frequency Distribution of Ratio of Mean N_2O Personal Air Level to Mean N_2O Exhaust Grill Area Air Level for General Surgeons

Ratio of mean N_2O personal air level to mean N_2O exhaust grille level	Frequency	Percent
less than 0.50	2	5.3
0.50 - 0.99	12	31.5
1.00 - 1.49	10	26.3
1.50 - 1.99	6	15.8
2.00 - 2.49	1	2.6
2.50 - 2.99	2	5.3
3.00 - 3.49	2	5.3
3.50 - 3.99	1	2.6
4.00 +	2	5.3
Total	38	100.0
median	1.13	

Table 38

N_2O:Halothane Administration Rate vs.
Range of N_2O: Halothane Personal Air Sampling Results

N_2O:Halothane Administration Rate	Range of N_2O:Halothane Personal Air Sampling Results
12.5	37.5 - 283.3
20.0	24.1 - 450.0
22.2	23.3 - 308.1
25.0	2.4 - 162.4
25.4	25.5 - 89.0
26.7	151.5 - 1,476.7
28.6	1.6 - 3.0
29.2	458.9 - 3,628.0
30.0	124.3 - 133.0
30.3	100.0 - 667.5
31.3	35.1 - 84.1
33.3	24.6 - 200.0
34.4	210.3 - 210.3
35.0	32.7 - 35.9
37.0	27.2 - 1,076.0
38.1	193.5 - 397.0
42.9	35.4 - 162.3
44.4	2.5 - 646.0
45.8	4.5 - 4.5
46.7	103.7 - 232.4
50.0	247.4 - 8,543.3
57.1	52.4 - 53.0
58.3	73.0 - 174.0
60.0	843.0 - 843.0
61.5	50.0 - 857.1
63.2	250.5 - 1,966.7
63.5	117.3 - 352.0
64.3	10.0 - 100.0
66.7	10.7 - 626.0
69.2	18.7 - 26.0
69.6	108.8 - 108.8
80.0	172.0 - 172.0
83.3	425.0 - 839.0
100.0	9.8 - 59.2
120.0	193.3 - 1,083.3
122.2	436.0 - 458.0
128.6	1,708.5 - 1,708.5
133.3	39.5 - 100.0
137.5	682.5 - 682.5
153.8	903.0 - 903.0

Table 39

N_2O:Enflurane Administration Rate vs.
Range of N_2O: Enflurane Personal Air Sampling Results

N_2O:Enflurane Administration Rate	Range of N_2O:Enflurane Personal Air Sampling Results
12.5	41.7 - 46.3
13.3	16.1 - 16.1
14.3	34.7 - 104.4
16.7	9.4 - 1,250.0
19.0	38.7 - 437.1
20.0	29.7 - 29.7
22.2	5.8 - 57.1
26.7	53.9 - 53.9
28.6	18.2 - 24.5
29.6	55.7 - 55.7
30.0	14.5 - 1,396.7
30.7	52.9 - 52.9
30.8	31.1 - 87.8
33.3	22.4 - 686.0
35.0	65.7 - 6,972.0
35.7	25.7 - 25.7
36.4	45.4 - 45.4
38.1	74.5 - 1,708.5
44.4	58.9 - 58.9
48.0	9.5 - 325.0
50.0	2.9 - 412.5
55.6	89.4 - 134.0
57.1	2.9 - 3.3
58.3	259.1 - 3,628.0
61.1	57.2 - 87.2
63.2	48.9 - 48.9
64.3	675.0 - 675.0
66.7	490.0 - 1,046.0
74.1	1,076.0 - 1,076.0
88.9	33.0 - 17,777.5
89.3	226.8 - 393.4
100.0	1.1 - 8,543.3
120.0	49.4 - 49.4
125.0	16.5 - 1,050.0
133.3	30.5 - 246.4
138.5	84.3 - 84.3
266.7	105.2 - 105.2

Table 40

N_2O:Isoflurane Administration Rate vs.
Range of N_2O: Isoflurane Personal Air Sampling Results

N_2O:Isoflurane Administration Rate	Range of N_2O:Isoflurane Personal Air Sampling Results
17.1	11.9 - 24.1
25.0	25.0 - 68.0
30.3	55.0 - 55.0
31.3	37.5 - 570.0
31.6	46.8 - 46.8
33.3	35.3 - 115.4
35.0	211.9 - 211.9
35.7	76.7 - 76.7
38.1	136.1 - 136.1
40.4	82.3 - 82.3
41.7	7.9 - 7.9
44.4	73.8 - 139.6
52.2	31.8 - 31.8
63.2	250.5 - 1,966.7
92.3	26.9 - 125.0
99.5	712.0 - 712.0
117.6	460.0 - 460.0

SUMMARY AND CONCLUSION:

a) Health Survey

i) The results of the health effects study suggest that there is an association between exposure to anesthetics and adverse reproductive outcomes.

ii) The multiple logistic regression analysis shows a positive association between exposure to anesthetics and spontaneous abortion. A history of previous spontaneous abortion was also found to be associated with spontaneous abortion. This supports the findings of the ASA AD HOC study in 1974.

iii) There is also an association with congenital abnormalities. Birth order was found to be positively associated with congenital abnormalities, with an increase in risk in later children.

iv) The mother's age at time of pregnancy was found to be a negative factor in the exposed females as compared to children of non-exposed females. Smoking habit of the mother during pregnancy was a positive factor with congenital abnormalities in children of exposed males, as compared to children of non-exposed males.

v) In addition, the survey data indicates an increased risk of adverse reproductive outcomes in the wives of exposed males. This is in agreement with other studies Cohen et al, 1975 & 1980. These studies were on dentists, and assuming that exposure to nitrous oxide was the significant factor, one may speculate that nitrous oxide exposure among the males in this study was also the significant factor.

vi) The results do not indicate a relationship between exposure to anesthetics and the incidence of chronic disease i.e. cancer/leukemia, liver, and kidney diseases in workers as a whole. An increased kidney disease rate was observed, as was reported by ASA, in the exposed female nurses as compared to non-exposed female nurses.

b) Hygiene survey

Dilution Ventilation

The Ontario Ministry of Health guideline for dilution ventilation in an operating room is 24 AC/hr. Dilution ventilation in the surgical/medical environment is required to meet other criteria than just waste anesthetic gas removal. It is needed for infection control, OR pressurization and to assist in providing requisite temperature/humidity conditions.

Analysis of the data shows that:

i) For each increase of 1 AC/hr. the overall N_2O area concentration would be reduced by 2.95 and the personal breathing zone by 1.63 ppm. Thus, for a hospital that has 20 air changes per hour the effect would be to reduce the overall area concentration by 60 ppm and the personal exposure by 32 ppm (assuming the reduction is linear over the whole range) regardless of the location of the fresh air grille or the return air grille;

ii) Only 23% of ORs meet the Ontario Ministry of Health criteria of 24 AC/hr;

iii) Many hospitals provided 100% fresh air during operations and allowed recirculation at night; and

iv) The effect of dilution ventilation on air contaminants is less than that of a scavenger regardless of the make, but the efficiency of control varied with the different scavenger makes. It should not be assumed from this that dilution ventilation may be excluded from a control strategy, as it must be provided but an effective air change rate of 24 AC/hr. by itself will not provide effective control of anesthetic gas in ORs.

Scavenging

Analysis of the data showed that:

i) In only 1% of the ORs surveyed were scavengers not present (3 out of 305); and

ii) A change in the scavenger make was found to change area concentration up to 214 ppm and personal exposures up to 96 ppm.

Leaks

Analysis of the data showed that:

i) All three major sources of leaks had a significant number of samples with results above 1,000 ppm as follows:

exhalation	41%
mask	35%
high pressure	30%

Thus, it was not possible to conclude that any one source of leakage was more prevalent than another;

ii) The leak source sampling at the exhalation valve had the highest number of samples with results above 1,000 ppm. Since essentially all hospitals have scavenging equipment, this would suggest that scavengers are not receiving proper service and maintenance; and

iii) There is a very poor correlation between personal exposure and leak source concentrations. This could have resulted from the sampling limitations of the survey.

Personal Exposure

Analysis of the data in regard to the source of gas administration in relation to personal exposure revealed the following:

i) Exposure of surgeons and scrub nurses was not higher when head and neck surgery was performed;

ii) No correlations were noted between the ratio of anesthetic gases at administration and the ratio of personal air levels; and

iii) The exhaust grille air sampling readings correlated with personal exposure values and gave a good representation of personal exposures except for the anesthetists. The anesthetists' personal exposure was 41% higher than the exhaust grille reading.

Hence, air sampling readings at the exhaust grille may be used to estimate the possible exposure to personnel in the OR except for the anesthetist.

N_2O/Halocarbon Ratio

Analysis of the data showed that:

i) The ratio of N_2O: halocarbon administered varied over a wide range from 12.5 to 266. However, the median values were close to 50 except for isoflurane which had a value of 39.3; and

ii) The general assumption that if N_2O is under control halocarbons will also be under control is essentially true. However, although the halocarbon data indicated that halothane and isoflurane are under excellent control, enflurane is not controlled to the same degree.

Exposure Limit (based on 8 hr)

It was found that 67% of the surgical procedures surveyed took less than one hour; however, for operating personnel (such as nurses, anesthetists) the exposure time is not limited to one procedure, but covers a number of procedures per shift (8 hours). It is clear therefore, that the time-weighted average exposure criteria for N_2O over one hour as suggested by NIOSH does not reflect the daily exposure to N_2O. The NIOSH recommendation seems to imply that the N_2O value over one hour is a STEL whereas standard hygiene practice limits the use of STEL values to a 15 minute exposure period and in addition, there is no justification for the one hour exposure value from the health effects point of view. Thus, in this study, the time-weighted average exposure for N_2O was calculated as an average over 8 hours.

Recommendations for Controlling Anesthetic Gases

1. The dilution ventilation as recommended by the Ontario Ministry of Health and other agencies should be provided in all operating rooms. It should be noted that the Ministry of Health recommends 24 air changes/hr.

2. No recirculation of exhaust air should be permitted during the hours when operations may be in progress. Recirculation of air during non-operating hours may be permitted.

3. Scavengers should be provided in all operating rooms to control gas release from the expiratory valve in the anesthetic circuit or equivalent in the ventilator.

4. Maintenance in each hospital should be the responsibility of a qualified staff member adequately trained in the repair and maintenance of anesthetic delivery systems. A high and low pressure leakage testing programme should involve testing the equipment every four months, and slip-over connections weekly. Also, testing of the effectiveness of the scavenger at the time of installation, and periodically thereafter.

5. A qualified staff member should be responsible for conducting periodic personal monitoring in ORs and RRs, and the sampling strategy should include individuals and the exhaust grilles.

6. N_2O exposure assessments can probably represent the adequacy of controls for all anesthetic gases.

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Ontario Ministry of Labour

ASA Questionnaire

CODE ☐☐☐☐☐☐☐☐☐☐☐☐☐ (1 2 3 4 5 6 7 8 9 10 11 12 13)

INSTRUCTIONS: Please fill out this form as completely as possible. Print numbers clearly in the appropriate boxes. Many answers require only a check.

PRESENT RESIDENCE: Suburban ☐ (14) Urban ☐ (15) Rural ☐ (16)

Birthdate: Mo ☐☐ Year 19☐☐ (17-20) Sex: M ☐ F ☐ (21)

WORKING ENVIRONMENT: Check area of your primary assignment (only one check for each year)

Year	OR	ICU	OB	Dental	Other Hospital Duties	Not Working In Hospital	
1971	☐	☐	☐	☐	☐	☐	(22)
1972	☐	☐	☐	☐	☐	☐	(23)
1973	☐	☐	☐	☐	☐	☐	(24)
1974	☐	☐	☐	☐	☐	☐	(25)
1975	☐	☐	☐	☐	☐	☐	(26)
1976	☐	☐	☐	☐	☐	☐	(27)
1977	☐	☐	☐	☐	☐	☐	(28)
1978	☐	☐	☐	☐	☐	☐	(29)
1979	☐	☐	☐	☐	☐	☐	(30)
1980	☐	☐	☐	☐	☐	☐	(31)

If you have not worked in the OR during the past 5 years, disregard the next four questions.

Are your operating rooms air conditioned? Yes ☐ No ☐ Don't Know ☐ (32)

Is this a recirculating ventilating system? Yes ☐ No ☐ Don't Know ☐ (33)

Are overflow anesthetic gases currently exhausted from the OR? Yes ☐ No ☐ Don't Know ☐ (34)

If yes, when was this system completed Month ☐☐ Year 19☐☐ (35-38) Don't Know ☐ (39)

QUESTIONS CONCERNING YOUR OWN HEALTH:

Have you ever had Cancer or Leukemia Yes ☐ No ☐ (40)

If yes, year of onset 19☐☐ (41-42)

Diagnosis: site _____ type _____

Have you had other health problems during the past 10 years?

Liver? Yes ☐ No ☐ (43) Diagnosis _____

Kidney? Yes ☐ No ☐ (44) Diagnosis _____

Other? Yes ☐ No ☐ (45) Diagnosis _____

QUESTIONS CONCERNING YOUR PREGNANCY HISTORY:

(for males, this section applies to your wife)

Have you been studied for infertility? Yes ☐ No ☐ (46)

If yes, what was the diagnosis? _____

Was an abnormality found? Yes ☐ No ☐ (47)

Total number of pregnancies ☐☐ (48-49)

Total number of pregnancies and miscarriages in the past ten years ☐☐ (50-51)

Additional comments after completing questionnaire: _____

_____

(please turn page)

Ontario Ministry of Labour

Pregnancy History During Past 10 Years

ASA Questionnaire

Code [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]
1 2 3 4 5 6 7 8 9 10 11 12 13

(For males, the following questions pertain to your spouse(s)). Use a separate line for each pregnancy (including miscarriages). In the event of multiple births list each child individually.

No. (7)	Age of Mother** (8-9)	Date of Birth or Abortion: Month (10-11)	Date of Birth or Abortion: Year (12-13)	Week of gestation (14-15)	RESULT OF PREGNANCY: Weight lbs. (16-17)	Weight ozs. (18-19)	Sex M (20)	Sex F (21)	Stillborn Yes (22)	Stillborn No (23)	Abortion Spont. (24)	Abortion Therap. (25)	TRIMESTER Check if either parent was working in the OR during pregnancy. 1st Mother (26)	1st Father (27)	2nd Mother (28)	2nd Father (29)	3rd Mother (30)	3rd Father (31)	CONTRACEPTION within 12 months prior to pregnancy: None (32)	Pill (33)	Other (34)
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					

No.	PREGNANCY HISTORY: Smoking during Pregnancy Cigarettes/Day None (36)	Under 20 (36)	Over 20 (37)	Rubella during Pregnancy Yes (38)	Rubella during Pregnancy No (39)	Abdominal X-ray or pelvimetry Yes (40)	Abdominal X-ray or pelvimetry No (41)	Congenital Abnormalities (See Table* & list each by letter & number from left eg. anencephaly = E 1) (42-43)	(44-45)	(46-47)	HEALTH OF CHILDREN BORN DURING PAST 10 YEARS: Cancer or Leukemia Yes (48)	No (49)	Age at Onset (50-51)	Site	Diagnosis Type	Death of Child Yes (52)	No (53)	Cause
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		

* TABLE OF CONGENITAL ABNORMALITIES:

A. Cardiovascular: 1. atrial septal defect 2. ventricular septal defect 3. patent ductus 4. other
B. Respiratory: 1. choanal atresia 2. diaphragmatic hernia 3. agenesis of lung 4. other
C. Musculoskeletal: 1. achondrodysplasia 2. syndactyly 3. limb amputation 4. other
D. Gastro intestinal: 1. cleft palate or lip 2. imperforate anus 3. omphalocoele 4. other
E. Central nervous system: 1. anencephaly 2. spina bifida 3. hydrocephalus 4. other
F. Urogenital: 1. extrophy of bladder 2. hypospadias 3. undescended testicle 4. other
G. Skin: 1. cavernous hemangioma 2. birthmark 3. nevus 4. other

** Age at Conception

2008 OHS(8/81)

Ontario Ministry of Labour

Pregnancy History Before 10 Years Ago

ASA Questionnaire Supplement

Code [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]
1 2 3 4 5 6 7 8 9 10 11 12 13

(For males, the following questions pertain to your spouse(s)). Use a separate line for each pregnancy (including miscarriages). In the event of multiple births list each child individually.

No. (7)	Age of Mother (8-9)	Date of Birth or Abortion: Month (10-11)	Date of Birth or Abortion: Year (12-13)	Week of gestation (14-15)	RESULT OF PREGNANCY: Weight lbs. (16-17)	Weight ozs. (18-19)	Sex M (20)	Sex F (21)	Stillborn Yes (22)	Stillborn No (23)	Abortion Spont. (24)	Abortion Therap. (25)	TRIMESTER (Check if either parent was working in the OR during pregnancy.) 1st Mother (26)	1st Father (27)	2nd Mother (28)	2nd Father (29)	3rd Mother (30)	3rd Father (31)	CONTRACEPTION within 12 months prior to pregnancy: None (32)	Pill (33)	Other (34)
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					

No.	PREGNANCY HISTORY: Smoking during Pregnancy: Cigarettes/Day None (35)	Under 20 (36)	Over 20 (37)	Rubella during Pregnancy: Yes (38)	No (39)	Abdominal X-ray or pelvimetry: Yes (40)	No (41)	Congenital Abnormalities (See Table* & list each by letter & number from left eg. anencephaly * E 1): (42-43)	(44-45)	(46-47)	HEALTH OF CHILDREN BORN BEFORE 10 YEARS AGO: Cancer or Leukemia: Yes (48)	No (49)	Age at Onset (50-51)	Site	Diagnosis	Type	Death of Child: Yes (52)	No (53)	Cause
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			

* TABLE OF CONGENITAL ABNORMALITIES:

A. Cardiovascular: 1. atrial septal defect 2. ventricular septal defect 3. patent ductus 4. other
B. Respiratory: 1. choanal atresia 2. diaphragmatic hernia 3. agenesis of lung 4. other
C. Musculoskeletal: 1. achondrodysplasia 2. syndactyly 3. limb amputation 4. other
D. Gastro intestinal: 1. cleft palate or lip 2. imperforate anus 3. omphalocoele 4. other
E. Central nervous system: 1. anencephaly 2. spina bifida 3. hydrocephalus 4. other
F. Urogenital: 1. extrophy of bladder 2. hypospadias 3. undescended testicle 4. other
G. Skin: 1. cavernous hemangioma 2. birthmark 3. nevus 4. other

2008 (04/83/E1)

Ontario
Ministry of
Labour

Ontario Questionnaire

Code 1 2 3 4 5 6 7 8 9 10 11 12 13

I. General

1. What is your type of job? (check one)

Anaesthesiologist	_____
Surgeon	_____
Obstetrician	_____
Dentist	_____
Technician, Operating Room	_____
Scrub Nurse, Operating Room	_____
Circulating Nurse, Operating Room	_____
Staff Nurse, Recovery Room	_____
Nurse's Aide or Orderly	_____
Other (specify)	_____

2. Where do you presently spend your time at work? Over an average week, for each of the places or activities listed below indicate

	Average number, days each week, working in this place or activity	Average number, hours each day, working in this place or activity
operating room(s)		
recovery room		
suite containing operating rooms (nearby corridors, lounges, etc.)		
dental surgeries (in hospital)		
delivery rooms (for Caesarian deliveries)		
other, with exposures to anaesthetic gases (specify)		
_____		
Other, without exposures to anaesthetic gases (specify)		
_____		

3. a. Past exposure history, including training. If different, please fill in.

Dates	Location or Activity	av. days/week	av. hours/day	hospital, city

(Use extra sheets, if needed).

b. Total number of years exposed to anaesthetics _____

4. a. Present weight _____ lbs., or _____ kg; weight steady or changing?

b. Height _____ feet _____ inches, or _____ cm.

5. Do you need any medicines for relaxation, sleep or to kill pain? (yes, no) _____. If yes, please list. _____

_____

_____

2008 OHS/81(11)

Ontario
Ministry of
Labour

Code | | | | | | | | | | | | | |
1 2 3 4 5 6 7 8 9 10 11 12 13

6. a. Have you had any problem with your eyes, besides needing glasses? (yes, no) _____ .

b. If yes, when were you told of this? (date) _____ .

c. How long did the problem last? (months, years) _____ .

d. How did your doctor explain the problem to you? (describe) _____

_____

_____

7. a. Have you had any problem with your hearing? (yes, no) _____ .

b. If yes, when were you told this? (date) _____ .

c. How long did the problem last? (months, years, continuing until now) _____

d. How did your doctor explain the problem to you? (describe) _____

_____

8. a. Do you drink socially? (yes, no) _____
b. If yes, list the amount per day _____ .
c. List types of drinks _____

_____

d. Do you smoke or have you smoked in the past? Yes ☐ No ☐

e. If yes, list cigarettes/day _____ over which years _____ .

Reproductive System — Women

9. a. Have you ever used birth control methods? (yes, no) _____ .

b. If yes, please fill in the following, where it applies.

Birth control method	date begun	how long used
birth control pills	_____	_____
IUD (intra-uterine device)	_____	_____

10. a. Have you had any problems with your menstrual periods? (yes, no) _____ .

b. If yes, did this start before your exposure to anaesthetics began? (yes, no) _____ .

c. If your answer to 10b. is "no", please fill in the following.

Type of problem	When did it begin (dates)	How long did it last
pains or cramps	_____	_____
midperiod spotting	_____	_____
excessive bleeding during period	_____	_____
irregular schedule of periods	_____	_____

d. Diagnosis if known _____

11. a. Give the dates of birth of each of the boys you have delivered who were healthy at birth. _____

Also, give how long you carried each baby in weeks or months and his weight at birth _____

b. Give the dates of birth of each of the girls you have delivered who were healthy at birth _____

Also, give how long you carried each baby, in weeks or months and her weight at birth _____ .

12. a. Were you ever trying to get pregnant but had difficulties, or could not get pregnant at all, but did not go for professional help? (yes, no) _____ .

b. If yes, please give dates _____ .

Ontario Ministry of Labour

Code 1 2 3 4 5 6 7 8 9 10 11 12 13

13. Health of all children: Please list all serious illnesses or other health problems of any of your children (including Cancer or Leukemia). Also enter problems in the growing up of your children which your doctor considered significant.

Pregnancy	Date of birth	Boy or girl	Date when health problem was recognized (diagnosed)	Describe health problem (diagnosis)	Hospital (and city) where child was treated	Significant problems in growing up (diagnosis)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						

(Use extra sheets, if needed)

14. Exposures during pregnancy

a.

Pregnancy	Dates of live births, healthy	Dates of live births with congenital birth defects	Dates of still-births	Dates of miscarriages Spont.	Therap.	Any alcohol consumed (yes, no)	Any medicine taken (prescription or non-prescription) (yes, no)
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

b. If any alcohol or medicines (prescription, including shots and skin medications, or non-prescription) were used, please fill in the following, as it applies to each pregnancy.

Pregnancy	Amount of alcohol consumed per day	Types of drinks consumed	Name or type of medicine	Dose of medicine taken per day
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

Ontario Ministry of Labour

Code 1 2 3 4 5 6 7 8 9 10 11 12 13

15. a. Has (have) your spouse(s) also been exposed to anaesthetics at work? (yes, no)____ .

b. If so, describe, giving dates and type of job where exposed. _____

_____

_____

(Use extra sheets, if needed).

c. Give date(s) of birth of your spouse(s) _____ .

16. Alcohol or medications taken by spouse(s).
a. Does your spouse drink socially? (yes, no)_____ .
b. If yes, list the amount per day_____ .
c. List types of drinks _____ .
d. Does your spouse take any medications? (yes, no)_____ .
e. If yes, list name or type of medicine _____ .
f. Dose of medicine taken per day _____ .

Reproductive System — Men

17. a. Was (were) your spouse(s) ever trying to get pregnant with you but had difficulties, or could not get pregnant at all, and did not go for professional help? (yes, no)_____ .

b. If this applies, please give dates _____

_____

18. Health of all children: Please list all serious illnesses or other health problems (including cancer or leukemia) of any children fathered by you. Also enter problems in the growing up of your children which your doctor considered significant.

Pregnancy	Date of birth	Boy or girl	Date when health problem was recognized (diagnosed)	Describe health problem (diagnosis)	Hospital (and city) where child was treated	Significant problems in growing up (diagnosis)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						

(Use extra sheets, if needed)

19. a. Has (have) your spouse(s) also been exposed to anaesthetics at work, when not pregnant? (yes, no) _____

b. If yes, describe, giving dates and type of job where exposed. _____

_____

_____

(Use extra sheet, if needed).

c. Give date(s) of birth of your spouse(s)_____ .

20. Alcohol or medications taken by spouse(s).
a. Does your spouse drink socially? (yes, no) _____ .
b. If yes, list the amount per day _____ .
c. List types of drinks _____ .
d. Does your spouse take any medications? (yes, no)_____ .
e. If yes, list name or type of medicine _____ .
f. Dose of medicine taken per day _____ .

APPENDIX B

ANAESTHETIC GASES PROJECT

GUIDE TO QUESTIONNAIRE

1. Introduction

The Anesthetic Gases Project Questionnaire is divided up into three sections:

1. "ASA Questionnaire" identical to original ASA Questionnaire administered to U.S. and some Canadians anaesthesiologists approximately 8 years ago. Certain items may appear at first glance unrelated to the exposure of certain staff, but this form was originally designed for anaesthesiologists; for our project no changes were made in this form so that statistical results obtained would be directly comparable to the larger U.S. sample.

2. "ASA Questionnaire Supplement" - indentical to p.2 of ASA Questionnaire except that it covers "Pregnancy History Before 10 Years ago" rather than as on p.2 "Pregnancy History During Past 10 Years."

3. "Ontario Questionnaire" asks for relevant information which was not covered in 1 and 2. For example, we ask about exposure history up to 1983, rather than up to 1980 as on ASA Questionnaire.

2. Specific Item on ASA Questionnaire	
CODE of 13 digits, (1)-(13)	Usually will be incomplete because personnel was a non-respondent. You are requested to attempt to complete the code to aid statistical analysis.
p.1, (14)-(16)	In order to achieve consistency present residence should be adhered to even if personnel has recently moved.
p.1, (22)-(31)	ICU as a category will apply to only a few people e.g. a few anaesthesiologists. If personnel works in R.R. write R.R. in red beside the check under "WORKING ENVIRONMENT, Other Hospital Duties."
	Note that on p.4, Section 2 and 3 of the Ontario Questionnaire allows for calculation of total present and past exposure hours up to 1983, whereas total exposure hours cannot be calculated from the ASA Questionnaire data base. Most OR nurses and anaesthesiologists work close to 40 hours/week in the OR, whereas OR hours for surgeons are usually less.

p.1, (32)-(39)

In order to achieve consistency, the OR suite for which these items are answered should be the one where the personnel is currently working even if the personnel has recently moved.

p.1, (40)-(45)

Most hospital personnel will understand and have information concerning "site" and "type" of cancer. If personnel indicates hepatitis under (43), attempt to determine if this is type B (serum) hepatitis since there is a known high incidence of type B hepatitis in hospital workers, espcially surgeons and anaesthesiologists. Some studies indicate an increase in liver disease with exposure of some personnel categories to anaesthetic gases.

Methoxyflurane used in the past had a known effect on the kidney, and some studies indicate an increase in kidney disease with exposure of some personnel categories to anaesthetic gases.

p.1, (46)-(51)

"Questions Concerning Your Pregnancy History" does not indicate any time limit except in items (50)-(51) where it is specifically stated "Total number of pregnancies and miscarriages in the past ten years." Note that Infertility diagnosis may apply to the male, e.g. "low sperm count" or "pituitary turmour."

p.2

Spouse(s) in this page and throughout the questionnaire means a couple living together at least one year without the use of birth control (whether married or not) and may be single or multiple.

p.2&3, "Pregnancy History During Past 10 Years and "Pregnancy History Before 10 Years Ago"

Note that if a child had congenital abnormalities, cancer, or leukemia, or any other serious illness, the hospital (and city) where child was treated as well as a brief description of the treatment with dates is to be recorded on p.6, item (13).

On p.3 ("Pregnancy History Before 10 Years Ago") to avoid confusion boxes (1)-(8) should be changed to (9)-(16), i.e:

p.3,

1	9
2	10
3	11
4	12
5	13
6	14
7	15
8	16

The phrase "Working in the OR" under the section "Trimester" in the context of p.2 and p.3 should be interpreted broadly to mean working anywhere in the OR in the suite.

3. Specific Item on Ontario Questionnaire

p.4, (1)-(3)

Nurses often alternate jobs, e.g. 1/2 time as Circulating Nurse and 1/2 time as Scrub Nurse. Estimate the proportion of time at each job and the number of hours spent at job as best

you can. Unless the combined time is much greater than about one hour, it is unnecessary to calculate shift time away from the OR suite spent at meals, coffee breaks, etc. Note that OR suite workers may include secretaries, pathologists and technicians. Workers are considered to be exposed if they spend at least two hours per week in the OR suite.Exposures during hobbies to e.g. solvents, pesticides, dusts, etc., should be noted under (3).

p.4, (5)

Not limited to medicines for relaxation, sleep, or to kill pain. List all medicines, even aspirin. Include street drugs. Attempt to obtain dose in mg or g/day. Any changes in consumption after working with anaesthetics, especially sleep medicines, tranquilizers?

p.5, (8)a-c

The following tabular form has proven useful in estimating alcohol consumption:

	day	week	month	year
drinks				
glasses			6 wine	
bottles	1 beer			

p.5, (8)d-e

List pack-years of cigarettes as closely as possible. If personnel has stopped smoking e.g.10 years ago, write STOPPED 10 YEARS AGO in red beside this question.

p.5, (6) and (7)

Some studies have indicated that there may be effects of anaesthetic gases on the senses.

Item on Ontario Reproductive System - Women

All items are to be answered by female personnel only

p.5, (9) a and b

One study mentions effect of anaesthetic gases on the menses. Both the pill and IUD may be confounding factors in our study. If female personnel have always used birth control methods, write ALWAYS in red beside (9)a.

p.5, (10) a-c	Under 10(c) "Type of problem", we are interested in any change in the pattern of menses for that individual. Use standard notation such as "28 days x 4 x light which changed to 52-28 days x 5 x moderate after working in OR x 1 year." Under 2(c) such diagnoses as fibroids, endometriosis etc., may be confounding factors in our study.
p.5, (11) a and b	Appears to be redundant but original ASA Questionnaire leaves out illnesses other than congenital birth defects, cancer, leukemia, and deaths.
p.6, (12) a and b	Covers case of infertility where no professional help was sought.
p.6, (13)	A partial list of developmental or mental problems is: hyperkinetic syndrome autism dyslexia "minimal brain dysfunction" mental retardation

p.6, (14) a and b

The purpose is to obtain information on alcohol or any drugs/medicine taken during specific pregnancies, which information is missing from p.2 and 3. Could be abbreviated to:

pregnancy	alcohol consumed	medicine taken
1-16	(amount, type)	(daily dose)

The questionnaire does not specifically ask for this information, but especially in the case of any miscarriage, stillbirth or birth defect, attempt to obtain at least approximate dates of alcohol and medicine/drug consumption e.g. 1st trimester, 2nd trimester, etc.

p.7, (15)

Besides anaesthetic exposure, any exposures of spouse during other work (e.g. lead plant) or hobbies should be mentioned.

p.7, (16) a-f	It is important to note when alcohol or medicines stopped and started, especially in relation to the period prior to a pregnancy of female personnel (or lack thereof).
Item on Ontario Questionnaire Reproductive System - Men	All items to be answered by male personnel only. If male personnel answers "yes" to this question, attempt to obtain reason/diagnosis for infertility, unless this is already clear from p.1, (46) and (47). Question is analogous to (12) a and b in "Reproductive System - Women", on p.5.
p.7, (18)-(20)	Note that these are analogous questions for male personnel as were asked of female personnel under "Reproductive System - Women."

Sheet to be given to Personnel

General Information

The Ministry of Labour is conducting a study re Exposure to Anaesthetic Gases in the Hospital. We are gathering data in order to determine if a hazard exists in Ontario. Medical Questionnaires are to be administered to all chronically exposed groups in the O.R. suite, including the recovery room. As well the Questionnaire is to be distributed to a non-exposed control group. This sheet is to inform you that you have been selected to complete the Medical Questionnaire either in the exposed or non-exposed category.

PLEASE NOTE that pregnancy history should be listed in reverse chronological order, that is on page 2 of the Medical Questionnaire "Pregnancy History During Past 10 Years" under item No. (7) start with latest birth, stillbirth, or abortion (which would have been or is your youngest child) first and list this pregnancy across from box (1), list the second latest pregnancy across from box (2), etc. Note that page 3 is "Pregnancy History Before 10 Years Ago" and any such pregnancy history if it exists is to be filled out as a continuation of page 2, that is latest pregnancy before 10 years ago should be listed across from box (1), etc.

You will be informed about the date and time of a followup interview with the Ministry of Labour Occupational Health Nursing Consultant. The interview will in general occur a few days after you have received the Questionnaire. (It will be helpful for identification purposes if you could bring bottles of any medications you normally take to the interview).

As part of the study we will also be assessing the ventilation in the O.R. suite as well as taking air samples in selected O.R. suite rooms. Some exposed personnel will be selected to give a personal air sample near their breathing zones. Not everyone filling out the Medical Questionnaire will be asked to give the personal air sample. Those personnel selected will be informed in advance and they will be asked to give their name to the Health Technician measuring the sample. A name is necessary so that the sample can be analyzed in the Occupational Health Laboratory. Results of sample as well as the interpretation of the results will be furnished to you through your Employee Health Service when they are available.

Confidentiality

Each interviewee will be assigned a code number to be used on the Medical Questionnaire. Your Questionnaire will be processed confidentially using that code number, not your name. Only the Chief Physician of the Occupatonal Health Branch and medical personnel designated by him have access to the code.

The Laboratory which must have your name to analyse the sample will not have access to the Medical Questionnaires.

None of the information provided by you will be seen by or reported to any Supervisory Personnel. Thank you for your cooperation.

REPORTED CHRONIC DISEASE - CANCER/LEUKEMIA AMONG THE EXPOSED RESPONDENTS

LIST	AGE AT CANCER ONSET IF KNOWN	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	CANCER/ LEUKEMIA ONSET YEAR	LTE PRIOR TO CANCER OCCURRENCE	CANCER/ LEUKEMIA SITE	CANCER/ LEUKEMIA TYPE
1	51	F	NURSE	45	83	96140	78	69483	SKIN	CARCINOMA
2	59	M	DOCTOR	42	82	31510	78	29819	SKIN	CARCINOMA
3	60	M	DOCTOR	39	82	50508	75	48576	SKIN	OTHER MALIGNANT
4	24	F	NURSE	74	83	12075	75	2070	SKIN	OTHER MALIGNANT
5	58	M	DOCTOR	54	54	117			LUNG	OTHER BENIGN
6	44	F	NURSE	74	82	6256	72	0	REPRODUCTIVE	UNCLASSIFIABLE
7	31	M	DOCTOR	70	82	27600	76	16100	SKIN	OTHER MALIGNANT
8	52	M	DOCTOR	48	82	42780	77	38180	SKIN	CARCINOMA
9	51	F	DOCTOR	53	82	3358	80	1099	REPRODUCTIVE	OTHER MALIGNANT
10	38	M	DOCTOR	73	82	2484	82	2484	SKIN	CYST
11	53	M	DOCTOR	55	82	64032	78	57592	SKIN	OTHER MALIGNANT
12	35	F	NURSE	65	82	28463	79	23288	REPRODUCTIVE	UNCLASSIFIABLE
13	42	F	NURSE	46	62	304	70	304	SKIN	UNCLASSIFIABLE
14	62	M	DOCTOR	46	72	17940	79	17940	SKIN	CARCINOMA
15	44	M	DOCTOR	65	82	9600			UNCLASSIFIABLE	UNCLASSIFIABLE
16	29	F	NURSE	78	82	4823	82	4823	REPRODUCTIVE	UNCLASSIFIABLE
17	48	M	DOCTOR	50	82	15180	81	14720	SKIN	CARCINOMA
18	56	F	NURSE	58	82	27117			UNCLASSIFIABLE	UNCLASSIFIABLE
19	37	M	DOCTOR	63	82	6210	74	5796	SKIN	CARCINOMA
20	47	M	DOCTOR	64	65	347			SKIN	CARCINOMA
21	44	F	NURSE	73	83	17250	76	6900	MUSCULOSKELETAL	LEUKEMIA UNSPEC.
22	28	F	DOCTOR	79	83	4535	71	0	REPRODUCTIVE	UNCLASSIFIABLE
23	29	F	NURSE	78	82	7728	81	6900	SKIN	CARCINOMA
24	46	M	DOCTOR	53	83	16790	75	13110	SKIN	OTHER MALIGNANT
25	43	M	DOCTOR	50	82	20148	67	11178	MUSCULOSKELETAL	SARCOMA
26	61	F	NURSE	38	82	20130	80	16445	REPRODUCTIVE	UNCLASSIFIABLE
27	40	F	NURSE	71	82	18975			UNCLASSIFIABLE	UNCLASSIFIABLE
28	55	F	DOCTOR	50	82	81949	77	61295	REPRODUCTIVE	UNCLASSIFIABLE
29	24	F	NURSE	59	82	14421	62	2208	ENDOCRINE/NERVOUS	CARCINOMA
30	53	M	DOCTOR				81		SKIN	UNCLASSIFIABLE
31	47	M	DOCTOR	58	82	48645	80	40825	SKIN	CARCINOMA
32	37	F	NURSE	65	78	14662	82	14662	REPRODUCTIVE	OTHER MALIGNANT
33	29	M	OTHER	62	68	11040	71	11040	ENDOCRINE/NERVOUS	UNCLASSIFIABLE
34	22	F	NURSE	69	82	3560	70	616	REPRODUCTIVE	CYST
35	24	F	NURSE	76	82	9660	81	7360	REPRODUCTIVE	UNCLASSIFIABLE
36	46	F	OTHER	77	82	9200	79	3588	BREAST	UNCLASSIFIABLE
37	32	F	NURSE	71	83	5704	83	5681	SKIN	OTHER MALIGNANT
38	25	F	NURSE	55	82	42320	62	9660	UNCLASSIFIABLE	OTHER MALIGNANT
39	24	F	DOCTOR	57	82	53268	57	1771	SKIN	OTHER MALIGNANT
40	52	F	DOCTOR	50	82	36800	76	29900	SKIN	OTHER MALIGNANT
41	52	M	DOCTOR	52	83		82		SKIN	OTHER MALIGNANT
42	29	M	DOCTOR	78	79	693			UNCLASSIFIABLE	UNCLASSIFIABLE
43	25	F	NURSE	57	83	29725	63	394	ENDOCRINE/NERVOUS	UNCLASSIFIABLE
44	29	F	NURSE	79	83	7520	81	6657	BREAST	UNCLASSIFIABLE
45	36	F	NURSE	58	82	21780	76	10740	REPRODUCTIVE	UNCLASSIFIABLE
46	48	F	OTHER	53	82	16845	80	16661	ENDOCRINE/NERVOUS	UNCLASSIFIABLE
47	46	M	DOCTOR	57	82	43823	77	33473	SKIN	OTHER MALIGNANT
48	40	F	NURSE	52	60	7912	72	7912	REPRODUCTIVE	UNCLASSIFIABLE

REPORTED CHRONIC DISEASE - CANCER/LEUKEMIA AMONG THE EXPOSED RESPONDENTS

LIST	AGE AT CANCER ONSET IF KNOWN	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	CANCER/ LEUKEMIA ONSET YEAR	LTE PRIOR TO CANCER OCCURRENCE	CANCER/ LEUKEMIA SITE	CANCER/ LEUKEMIA TYPE
49	33	F	NURSE	71	82	17250	81	15525	SKIN	CARCINOMA
50	33	F	NURSE	67	82	18718	82	18604	REPRODUCTIVE	UNCLASSIFIABLE
51	40	M	DOCTOR	56	82	55890	68	24840	SKIN	CARCINOMA
52	37	F	NURSE	60	60	862	76	862	REPRODUCTIVE	CARCINOMA
53	35	F	NURSE	80	81	2208	77	0	BREAST	CARCINOMA
54	16	M	DOCTOR	72	83	6624	58	0	LUNG	UNCLASSIFIABLE
55	37	F	NURSE	64	82	28524	77	23520	REPRODUCTIVE	UNCLASSIFIABLE
56	47	M	DOCTOR	62	69	9660	82	9660	MUSCULOSKELETAL	CHRONIC LEUKEMIA
57	42	F	NURSE	59	83	17940	79	11040	REPRODUCTIVE	CARCINOMA
58	43	F	NURSE	56	83	6715	79	4780	BREAST	CARCINOMA
59	49	F	OTHER	65	83	31050	79	24150	REPRODUCTIVE	UNCLASSIFIABLE
60	30	M	DOCTOR	78	84	12512	78	0	MUSCULOSKELETAL	SARCOMA
61	42	M	DOCTOR	55	83	5152	74	3496	ENDOCRINE/NERVOUS	OTHER MALIGNANT
62	57	M	DOCTOR	52	82	31050	79	25875	URINARY	UNCLASSIFIABLE
63	31	F	NURSE	71	82	18975	79	13800	REPRODUCTIVE	UNCLASSIFIABLE
64	50	M	DOCTOR	56	82	12199	82	12199	SKIN	OTHER MALIGNANT
65	47	M	DOCTOR	60	84	16445	78	13340	MUSCULOSKELETAL	LEUKEMIA UNSPEC.
66	53	F	DOCTOR	50	60	4600	75	4600	ENDOCRINE/NERVOUS	UNCLASSIFIABLE
67	35	F	NURSE	47	82	33818	64	10214	BREAST	CARCINOMA
68	51	M	DOCTOR	52	83	8458	78	6986	SKIN	CARCINOMA
69	71	M	DOCTOR	40	80	35880			MUSCULOSKELETAL	CHRONIC LEUKEMIA
70	25	F	DOCTOR	76	82	13662	75	0	ENDOCRINE/NERVOUS	PAPILLOMA
71	26	F	NURSE	67	82	9480	50	0	SKIN	OTHER MALIGNANT
72	18	M	DOCTOR	82	82	662	75	0	MUSCULOSKELETAL	SARCOMA
73	26	F	DOCTOR	75	81	161	78	161	MUSCULOSKELETAL	OTHER MALIGNANT
74	42	M	DOCTOR	58	83		74		SKIN	CARCINOMA
75	40	F	NURSE	63	83	34500	81	31050	BREAST	UNCLASSIFIABLE
76	49	M	DOCTOR	51	83	28658	75	26450	SKIN	OTHER MALIGNANT
77	52	M	DOCTOR	59	82	15640	80	14490	DIGESTIVE TRACT	CARCINOMA
78	51	M	DOCTOR	55	82	8694	82	8694	SKIN	OTHER BENIGN
79	58	M	DOCTOR	44	82	19849	78	18193	DIGESTIVE TRACT	CARCINOMA
80	47	M	DOCTOR	52	82	20700	70	12420	SKIN	CARCINOMA
81	49	M	DOCTOR	41	82	37720	69	25760	URINARY	PAPILLOMA
82	47	F	NURSE	48	82	34808	70	17940	DIGESTIVE TRACT	OTHER BENIGN
83	30	F	NURSE	72	82	17250	67	0	DIGESTIVE TRACT	UNCLASSIFIABLE
84	-1	M	DOCTOR	49	60	432	83	432	URINARY	OTHER MALIGNANT
85	25	F	NURSE	69	81	22425	72	6900	REPRODUCTIVE	OTHER MALIGNANT
86	28	F	NURSE	69	81	20240	78	15640	REPRODUCTIVE	OTHER MALIGNANT
87	58	M	DOCTOR	41	45	460	75	460	URINARY	CARCINOMA
88	27	F	NURSE	67	82	26335	74	12535	REPRODUCTIVE	UNCLASSIFIABLE
89	66	M	DOCTOR	39	82	3450	80	2829	URINARY	UNCLASSIFIABLE
90	42	F	DOCTOR	64	82	6766			REPRODUCTIVE	UNCLASSIFIABLE
91	46	M	OTHER	73	82	15525	79	10350	SKIN	OTHER MALIGNANT
92	52	F	NURSE	47	47		80		REPRODUCTIVE	UNCLASSIFIABLE
93	56	F	OTHER	77	82	6900	81	5175	DIGESTIVE TRACT	UNCLASSIFIABLE
94	35	M	DOCTOR	68	83	5152	72	3128	REPRODUCTIVE	OTHER MALIGNANT
95	42	M	DOCTOR	60	65	12144	78	10764	URINARY	UNCLASSIFIABLE
96	35	F	NURSE	62	82	21353	78	16270	REPRODUCTIVE	UNCLASSIFIABLE

REPORTED CHRONIC DISEASE - CANCER/LEUKEMIA AMONG THE EXPOSED RESPONDENTS

LIST	AGE AT CANCER ONSET IF KNOWN	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	CANCER/ LEUKEMIA ONSET YEAR	LTE PRIOR TO CANCER OCCURRENCE	CANCER/ LEUKEMIA SITE	CANCER/ LEUKEMIA TYPE
97	26	F	NURSE	62	82	28760	68	9440	REPRODUCTIVE	OTHER MALIGNANT
98	34	F	NURSE	60	82	18849	76	8776	SKIN	CARCINOMA
99	45	M	DOCTOR	51	80	2484	71	1840	SKIN	CARCINOMA
100	49	M	DOCTOR	57	61	3680	78	3680	SKIN	CARCINOMA
101	18	M	DOCTOR	53	72	2191	57	1557	MUSCULOSKELETAL	SARCOMA
102	65	M	DOCTOR	36	80	15511	77	14959	LUNG	CARCINOMA
103	58	M	OTHER				81		LUNG	UNCLASSIFIABLE
104	57	F	NURSE	48	78	5520	81	5520	SKIN	CARCINOMA
105	49	F	NURSE	52	82	4758	78	2113	REPRODUCTIVE	CARCINOMA
106	45	F	NURSE	53	82	38353	79	34960	BREAST	CARCINOMA
107	33	F	NURSE	68	82	13855			UNCLASSIFIABLE	UNCLASSIFIABLE
108	31	F	NURSE	70	82	14952	81	14607	SKIN	CARCINOMA
109	56	F	NURSE	46	82	9110	79	8280	REPRODUCTIVE	UNCLASSIFIABLE
110	37	M	DOCTOR	70	82	552			UNCLASSIFIABLE	UNCLASSIFIABLE
111	68	M	DOCTOR	38	81	2262	81	2262	SKIN	UNCLASSIFIABLE
112	42	M	DOCTOR	66	83	35190	83	34155	SKIN	CARCINOMA
113	29	F	NURSE	78	81	7600	79	2080	REPRODUCTIVE	UNCLASSIFIABLE
114	64	M	DOCTOR	45	83	11431	73	10580	SKIN	OTHER MALIGNANT
115	24	M	DOCTOR	46	47	1840	48	1840	MUSCULOSKELETAL	OTHER BENIGN
116	42	M	DOCTOR	54	55		70		MUSCULOSKELETAL	OTHER MALIGNANT
117	43	M	DOCTOR	56	57		75		SKIN	CARCINOMA
118	46	M	DOCTOR	52	83	16275	80	12938	SKIN	CARCINOMA
119	31	M	DOCTOR	46	83	53809	54	15583	MUSCULOSKELETAL	OTHER BENIGN
120	38	M	DOCTOR	73	73	4355	79	4355	URINARY	CARCINOMA
121	39	F	NURSE	59	82	38880	78	27840	REPRODUCTIVE	UNCLASSIFIABLE
122	19	F	NURSE	77	77	616	66	0	MUSCULOSKELETAL	SARCOMA
123	48	M	OTHER	51	82	10695	77	10350	SKIN	OTHER MALIGNANT
124	34	F	NURSE	60	62	3680	71	3680	REPRODUCTIVE	UNCLASSIFIABLE
125	34	F	NURSE	71	83	10856	77	3680	REPRODUCTIVE	UNCLASSIFIABLE
126	25	F	NURSE	70	70	462	77	462	SKIN	CARCINOMA
127	38	F	NURSE	61	81	32775	76	27600	BREAST	UNCLASSIFIABLE
128	35	F	NURSE	64	81	20930	77	16790	REPRODUCTIVE	UNCLASSIFIABLE
129	45	F	NURSE	65	83	15666	75	7938	BREAST	UNCLASSIFIABLE
130	52	M	DOCTOR	54	57		79		SKIN	CARCINOMA
131	35	F	NURSE	62	82	10581	78	10031	REPRODUCTIVE	CARCINOMA
132	39	F	NURSE	62	65	209			REPRODUCTIVE	CARCINOMA
133	40	F	NURSE	79	82	552	68	0	BREAST	UNCLASSIFIABLE

REPORTED CHRONIC DISEASE - CANCER/LEUKEMIA AMONG THE NON-EXPOSED RESPONDENTS

LIST	AGE AT CANCER ONSET IF KNOWN	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	CANCER/ LEUKEMIA ONSET YEAR	LTE PRIOR TO CANCER OCCURRENCE	CANCER/ LEUKEMIA SITE	CANCER/ LEUKEMIA TYPE
1	50	F	OTHER	NOT APPLICABLE			76	NOT APPLICABLE	BREAST	CARCINOMA
2	22	F	OTHER				77		REPRODUCTIVE	UNCLASSIFIABLE
3	43	F	NURSE				80		SKIN	CARCINOMA
4	40	M	DOCTOR				70		REPRODUCTIVE	UNCLASSIFIABLE
5	44	M	DOCTOR				83		DIGESTIVE TRACT	CARCINOMA
6	36	F	OTHER				81		REPRODUCTIVE	UNCLASSIFIABLE
7	43	F	OTHER				67		REPRODUCTIVE	UNCLASSIFIABLE
8	61	F	OTHER						BREAST	CARCINOMA
9	60	F	DOCTOR						REPRODUCTIVE	CARCINOMA
10	24	F	OTHER						REPRODUCTIVE	UNCLASSIFIABLE
11	40	F	OTHER				68		REPRODUCTIVE	UNCLASSIFIABLE
12	24	F	NURSE				74		SKIN	OTHER MALIGNANT
13	28	M	OTHER				64		SKIN	CARCINOMA
14	34	F	OTHER				82		REPRODUCTIVE	UNCLASSIFIABLE
15	31	F	NURSE				79		REPRODUCTIVE	CARCINOMA
16	54	F	NURSE						REPRODUCTIVE	OTHER MALIGNANT
17	30	M	DOCTOR				65		ENDOCRINE/NERVOUS	UNCLASSIFIABLE
18	31	F	OTHER				69		REPRODUCTIVE	UNCLASSIFIABLE
19	35	M	DOCTOR				82		SKIN	CARCINOMA
20	30	M	DOCTOR				70		SKIN	CARCINOMA
21	44	F	NURSE				79		BREAST	UNCLASSIFIABLE
22	50	M	DOCTOR				81		SKIN	OTHER MALIGNANT
23	41	F	NURSE				74		REPRODUCTIVE	UNCLASSIFIABLE
24	37	M	OTHER				81		SKIN	OTHER MALIGNANT
25	25	F	OTHER				81		REPRODUCTIVE	UNCLASSIFIABLE
26	32	F	OTHER				81		REPRODUCTIVE	UNCLASSIFIABLE
27	62	M	DOCTOR				81		DIGESTIVE TRACT	UNCLASSIFIABLE
28	36	F	OTHER				73		REPRODUCTIVE	UNCLASSIFIABLE
29	28	F	OTHER				80		REPRODUCTIVE	UNCLASSIFIABLE
30	67	M	DOCTOR				81		UNCLASSIFIABLE	UNCLASSIFIABLE
31	54	M	DOCTOR				82		UNCLASSIFIABLE	LEUKEMIA UNSPEC,
32	22	F	NURSE				78		REPRODUCTIVE	CARCINOMA
33	41	F	NURSE				73		BREAST	CARCINOMA
34	26	F	OTHER				79		REPRODUCTIVE	UNCLASSIFIABLE
35	46	F	OTHER				76		REPRODUCTIVE	UNCLASSIFIABLE
36	27	M	DOCTOR				76		ENDOCRINE/NERVOUS	CARCINOMA
37	53	F	NURSE				78		BREAST	CARCINOMA
38	61	F	NURSE				80		BREAST	CARCINOMA
39	15	F	NURSE				70		BREAST	CYST
40	38	F	OTHER				79		SKIN	CARCINOMA
41	20	F	NURSE				72		REPRODUCTIVE	OTHER MALIGNANT

REPORTED CHRONIC DISEASE - CANCER/LEUKEMIA AMONG THE RANDOM SAMPLE RESPONDENTS

LIST	AGE AT CANCER ONSET IF KNOWN	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	CANCER/ LEUKEMIA ONSET YEAR	LTE PRIOR TO CANCER OCCURRENCE	CANCER/ LEUKEMIA SITE	CANCER/ LEUKEMIA TYPE
1	51	F	NURSE	45	83	96140	78	69483	SKIN	CARCINOMA
2	24	F	NURSE	74	83	12075	75	2070	SKIN	OTHER MALIGNANT
3	38	M	DOCTOR	73	82	2484	82	2484	SKIN	CYST
4	46	M	DOCTOR	53	83	16790	75	13110	SKIN	OTHER MALIGNANT
5	24	F	NURSE	59	82	14421	62	2208	ENDOCRINE/NERVOUS	CARCINOMA
6	46	F	OTHER	77	82	9200	79	3588	BREAST	UNCLASSIFIABLE
7	32	F	NURSE	71	83	5704	83	5681	SKIN	OTHER MALIGNANT
8	16	M	DOCTOR	72	83	6624	58	0	LUNG	UNCLASSIFIABLE
9	30	M	DOCTOR	78	84	12512	78	0	MUSCULOSKELETAL	SARCOMA
10	50	M	DOCTOR	56	82	12199	82	12199	SKIN	OTHER MALIGNANT
11	47	M	DOCTOR	60	84	16445	78	13340	MUSCULOSKELETAL	LEUKEMIA UNSPEC.
12	51	M	DOCTOR	52	83	8458	78	6986	SKIN	CARCINOMA
13	40	F	NURSE	63	83	34500	81	31050	BREAST	UNCLASSIFIABLE
14	47	M	DOCTOR	52	82	20700	70	12420	SKIN	CARCINOMA
15	35	M	DOCTOR	68	83	5152	72	3128	REPRODUCTIVE	OTHER MALIGNANT
16	42	M	DOCTOR	60	65	12144	78	10764	URINARY	UNCLASSIFIABLE
17	35	F	NURSE	62	82	21353	78	16270	REPRODUCTIVE	UNCLASSIFIABLE
18	31	F	NURSE	70	82	14952	81	14607	SKIN	CARCINOMA
19	46	M	DOCTOR	52	83	16275	80	12938	SKIN	CARCINOMA
20	31	M	DOCTOR	46	83	53809	54	15583	MUSCULOSKELETAL	OTHER BENIGN

REPORTED CHRONIC DISEASE - LIVER DISEASE AMONG THE EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	LIVER DISEASE
1	35	F	NURSE	71	82	18975	DISORDER
2	30	F	NURSE	81	83	2415	DISORDER
3	52	F	NURSE	73	81		DISORDER
4	30	F	NURSE	72	81	12058	DISORDER
5	59	M	DOCTOR	51	82	10626	HEPATITIS
6	37	M	DOCTOR			391	HEPATITIS
7	41	M	DOCTOR	63	72	828	HEPATITIS
8	39	M	DOCTOR	68	82	2438	HEPATITIS
9	44	F	NURSE	78	83	5520	HEPATITIS
10	48	F	NURSE	68	82	20860	HEPATITIS
11	35	M	DOCTOR	71	82	20470	HEPATITIS
12	53	M	DOCTOR	57	82	46000	HEPATITIS
13	32	F	NURSE	68	82	18188	HEPATITIS
14	42	F	NURSE	63	82	1001	HEPATITIS
15	38	M	DOCTOR	69	82	23920	HEPATITIS
16	53	M	OTHER	70	82	924	HEPATITIS
17	49	F	NURSE	56	82	44562	HEPATITIS
18	51	F	OTHER	77	83	10350	HEPATITIS
19	30	F	OTHER	82	82	308	HEPATITIS
20	38	M	DOCTOR	73	82	16284	HEPATITIS
21	35	M	DOCTOR	77	82	5520	HEPATITIS
22	38	M	DOCTOR	69	82	11960	HEPATITIS
23	28	F	NURSE	74	83	7567	HEPATITIS
24	32	F	NURSE	70	82	3864	HEPATITIS
25	33	M	DOCTOR	76	82	11684	HEPATITIS
26	29	F	NURSE	70	82	6492	HEPATITIS
27	44	M	DOCTOR	73	83	2760	HEPATITIS
28	43	M	DOCTOR	59	83	22080	HEPATITIS
29	62	F	DOCTOR	50	60	4600	HEPATITIS
30	56	M	DOCTOR	49	83	38548	HEPATITIS
31	53	F	NURSE	75	82	5796	HEPATITIS
32	51	M	DOCTOR	60	82	7257	HEPATITIS
33	33	M	DOCTOR	74	74	460	HEPATITIS
34	36	M	DOCTOR	67	76	9200	HEPATITIS
35	56	M	DOCTOR	51	55	6900	HEPATITIS
36	42	M	DOCTOR	62	72	26312	HEPATITIS
37	31	M	DOCTOR	78	80	462	HEPATITIS
38	62	M	DOCTOR	45	77	2898	HEPATITIS
39	44	M	DOCTOR	63	83	4600	HEPATITIS
40	32	M	DOCTOR	77	83	13800	HEPATITIS
41	39	F	NURSE	67	82	6084	HEPATITIS
42	28	F	NURSE	73	82	1564	HEPATITIS
43	33	M	NURSE	79	82	5175	HEPATITIS
44	59	M	DOCTOR	53	82	66033	HEPATITIS
45	52	F	NURSE	52	53	400	HEPATITIS
46	48	M	DOCTOR	64	68	12420	HEPATITIS
47	63	M	DOCTOR	46	81	72726	HEPATITIS
48	54	M	DOCTOR	58	81	12558	HEPATITIS

REPORTED CHRONIC DISEASE - LIVER DISEASE AMONG THE EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	LIVER DISEASE
49	30	F	NURSE	75	82	12478	HEPATITIS
50	38	M	NURSE	67	67	1540	HEPATITIS
51	33	M	DOCTOR	76	82	414	HEPATITIS
52	55	M	DOCTOR	55	82	27140	HEPATITIS
53	32	M	OTHER	73	82	2128	HEPATITIS
54	37	M	DOCTOR	69	69	3864	HEPATITIS
55	39	M	DOCTOR	65	82	782	HEPATITIS
56	39	M	DOCTOR	71	82	17204	HEPATITIS
57	58	F	NURSE	46	82	41408	HEPATITIS
58	35	M	DOCTOR	73	83	5520	HEPATITIS
59	26	M	DOCTOR	80	81	1380	HEPATITIS
60	35	M	DOCTOR	72	83	19642	HEPATITIS
61	28	M	NURSE	82	83	1840	HEPATITIS
62	62	M	DOCTOR	58	83	1530	HEPATITIS
63	29	F	DOCTOR	80	83	920	HEPATITIS
64	48	M	DOCTOR	61	83	12144	HEPATITIS
65	47	F	OTHER	81	82	1668	HEPATITIS
66	35	M	OTHER	75	79	6440	HEPATITIS
67	54	M	DOCTOR	54	83	31648	HEPATITIS
68	57	M	DOCTOR	51	83	20723	HEPATITIS
69	55	M	DOCTOR	51	82	4009	HEPATITIS
70	43	F	NURSE	80	81	3450	OBSTRUCTION
71	37	M	DOCTOR	73	75	1610	OBSTRUCTION
72	34	F	NURSE	65	82	28865	UNCLASSIFIABLE
73	43	F	NURSE	58	82	20223	UNCLASSIFIABLE
74	48	M	NURSE	71	82	18975	UNCLASSIFIABLE
75	38	F	NURSE	64	82	15468	UNCLASSIFIABLE
76	44	F	NURSE	61	83	38995	UNCLASSIFIABLE
77	41	F	NURSE	60	64	4298	UNCLASSIFIABLE
78	38	F	NURSE	67	82	17756	UNCLASSIFIABLE
79	56	M	DOCTOR	52	82	12420	UNCLASSIFIABLE
80	60	F	DOCTOR	50	82	81949	UNCLASSIFIABLE
81	45	M	DOCTOR	60	82	4048	UNCLASSIFIABLE
82	34	M	OTHER	76	82	11040	UNCLASSIFIABLE
83	51	M	DOCTOR	55	82	31158	UNCLASSIFIABLE
84	50	F	OTHER	77	81	8625	UNCLASSIFIABLE
85	60	M	DOCTOR	78	82	46230	UNCLASSIFIABLE
86	62	M	DOCTOR	47	82	28175	UNCLASSIFIABLE
87	37	M	DOCTOR	61	71		UNCLASSIFIABLE
88	32	F	NURSE	74	82	7065	UNCLASSIFIABLE
89	34	F	NURSE	70	82	8625	UNCLASSIFIABLE
90	42	F	NURSE	61	81	23437	UNCLASSIFIABLE
91	26	F	NURSE	75	81	1139	UNCLASSIFIABLE
92	52	F	NURSE	51	82	71829	UNCLASSIFIABLE
93	45	F	NURSE	62	82	32028	UNCLASSIFIABLE
94	37	F	NURSE	64	82	22540	UNCLASSIFIABLE
95	32	F	NURSE	70	82	13869	UNCLASSIFIABLE
96	48	M	DOCTOR	59	83	31625	UNCLASSIFIABLE

REPORTED CHRONIC DISEASE - LIVER DISEASE AMONG THE EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	LIVER DISEASE
97	34	M	DOCTOR	72	83	2484	UNCLASSIFIABLE
98	37	M	DOCTOR	77	83	3887	UNCLASSIFIABLE
99	45	M	DOCTOR	60	82	6072	UNCLASSIFIABLE
100	63	F	OTHER	59	83	44160	UNCLASSIFIABLE
101	40	F	DOCTOR	68	83	27416	UNCLASSIFIABLE
102	37	M	DOCTOR	66	79	5072	UNCLASSIFIABLE
103	36	M	DOCTOR	69	82	2486	UNCLASSIFIABLE
104	47	F	NURSE	58	83	42320	UNCLASSIFIABLE
105	40	M	DOCTOR	69	83	5152	UNCLASSIFIABLE

REPORTED CHRONIC DISEASE - LIVER DISEASE AMONG THE NON-EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	LIVER DISEASE
1	53	M	DOCTOR	NOT APPLICABLE			DISORDER
2	35	F	NURSE				DISORDER
3	63	M	DOCTOR				DISORDER
4	51	M	OTHER				HEPATITIS
5	35	M	DOCTOR				HEPATITIS
6	37	M	NURSE				HEPATITIS
7	61	M	DOCTOR				HEPATITIS
8	59	M	DOCTOR				HEPATITIS
9	28	F	NURSE				HEPATITIS
10	26	F	NURSE				HEPATITIS
11	30	F	NURSE				HEPATITIS
12	28	F	NURSE				HEPATITIS
13	25	F	NURSE				HEPATITIS
14	43	F	NURSE				HEPATITIS
15	31	F	OTHER				HEPATITIS
16	54	M	DOCTOR				HEPATITIS
17	32	M	OTHER				HEPATITIS
18	54	M	DOCTOR				HEPATITIS
19	37	F	OTHER				OBSTRUCTION
20	24	F	NURSE				UNCLASSIFIABLE
21	39	F	OTHER				UNCLASSIFIABLE
22	29	F	NURSE				UNCLASSIFIABLE
23	23	F	NURSE				UNCLASSIFIABLE
24	22	M	OTHER				UNCLASSIFIABLE
25	36	M	DOCTOR				UNCLASSIFIABLE
26	23	M	DOCTOR				UNCLASSIFIABLE

REPORTED CHRONIC DISEASE - LIVER DISEASE AMONG THE RANDOM SAMPLE RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	LIVER DISEASE
1	30	F	NURSE	81	83	2415	DISORDER
2	59	M	DOCTOR	51	82	10626	HEPATITIS
3	53	M	OTHER	70	82	924	HEPATITIS
4	51	F	OTHER	77	83	10350	HEPATITIS
5	33	M	DOCTOR	76	82	11684	HEPATITIS
6	29	F	NURSE	70	82	6492	HEPATITIS
7	32	M	DOCTOR	77	83	13800	HEPATITIS
8	39	F	NURSE	67	82	6084	HEPATITIS
9	54	M	DOCTOR	58	81	12558	HEPATITIS
10	30	F	NURSE	75	82	12478	HEPATITIS
11	55	M	DOCTOR	55	82	27140	HEPATITIS
12	47	F	OTHER	81	82	1668	HEPATITIS
13	43	F	NURSE	58	82	20223	UNCLASSIFIABLE
14	56	M	DOCTOR	52	82	12420	UNCLASSIFIABLE
15	50	F	OTHER	77	81	8625	UNCLASSIFIABL
16	60	M	DOCTOR	78	82	46230	UNCLASSIFIABL
17	32	F	NURSE	74	82	7065	UNCLASSIFIABLE
18	34	F	NURSE	70	82	8625	UNCLASSIFIABLE
19	48	M	DOCTOR	59	83	31625	UNCLASSIFIABLE
20	40	F	DOCTOR	68	83	27416	UNCLASSIFIABLE

REPORTED CHRONIC DISEASE - KIDNEY/URINARY TRACT DISEASE AMONG THE EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	URINARY TRACT DISEASE
1	47	F	DOCTOR	62	64	357	ACUTE RENAL FAIL
2	32	M	DOCTOR	76	76	460	ACUTE RENAL FAIL
3	54	F	NURSE	48	49	3312	ASYMP OBSTRUCT
4	57	M	DOCTOR	55	82	14904	ASYMP OBSTRUCT
5	51	F	NURSE	49	82	1705	ASYMP OBSTRUCT
6	39	F	OTHER	81	82	1294	ASYMP OBSTRUCT
7	44	M	DOCTOR	64	67	1890	ASYMP OBSTRUCT
8	50	M	DOCTOR	59	83	46736	CHRON RENAL FAIL
9	56	F	NURSE	49	49	432	HYPERTENSION
10	46	F	NURSE	53	56	920	HYPERTENSION
11	29	F	DOCTOR	74	82	1208	NEPHRLITHIASIS
12	43	M	DOCTOR	63	82	22080	NEPHRLITHIASIS
13	57	M	DOCTOR	49	82	9108	NEPHRLITHIASIS
14	62	M	DOCTOR	46	83	34086	NEPHRLITHIASIS
15	52	M	DOCTOR	55	56	231	NEPHRLITHIASIS
16	30	F	NURSE	74	74	331	NEPHRLITHIASIS
17	37	M	DOCTOR			391	NEPHRLITHIASIS
18	48	M	DOCTOR	61	82	1380	NEPHRLITHIASIS
19	57	M	DOCTOR	54	83	72680	NEPHRLITHIASIS
20	37	F	NURSE	70	82	15870	NEPHRLITHIASIS
21	41	M	DOCTOR	64	82	12903	NEPHRLITHIASIS
22	28	M	OTHER	81	82	1725	NEPHRLITHIASIS
23	57	M	DOCTOR	53	82	16836	NEPHRLITHIASIS
24	52	F	OTHER	75	82	11213	NEPHRLITHIASIS
25	52	F	NURSE	50	51	3312	NEPHRLITHIASIS
26	34	F	NURSE	73	82	13800	NEPHRLITHIASIS
27	29	F	NURSE	75	82	12075	NEPHRLITHIASIS
28	40	F	NURSE	71	82	18975	NEPHRLITHIASIS
29	52	F	OTHER	78	82	7360	NEPHRLITHIASIS
30	48	F	OTHER	75	83	5175	NEPHRLITHIASIS
31	45	F	NURSE	56	72	17683	NEPHRLITHIASIS
32	67	M	DOCTOR	43	43	982	NEPHRLITHIASIS
33	34	F	NURSE	77	82	9664	NEPHRLITHIASIS
34	26	F	NURSE	77	82	9660	NEPHRLITHIASIS
35	54	F	OTHER	64	82	24495	NEPHRLITHIASIS
36	29	F	NURSE	81	82	2392	NEPHRLITHIASIS
37	51	M	DOCTOR	55	82	31158	NEPHRLITHIASIS
38	48	M	DOCTOR	60	83	38007	NEPHRLITHIASIS
39	47	M	DOCTOR	58	83	4600	NEPHRLITHIASIS
40	40	F	NURSE	63	83	11933	NEPHRLITHIASIS
41	62	M	DOCTOR	49	82	33350	NEPHRLITHIASIS
42	42	F	NURSE	60	81	37260	NEPHRLITHIASIS
43	35	F	NURSE	76	81	10350	NEPHRLITHIASIS
44	33	M	DOCTOR	74	81	1816	NEPHRLITHIASIS
45	39	F	NURSE	65	82	22388	NEPHRLITHIASIS
46	69	M	DOCTOR	38	44	2737	NEPHRLITHIASIS
47	61	M	DOCTOR	52	65	5980	NEPHRLITHIASIS
48	57	M	DOCTOR	60	60	866	NEPHRLITHIASIS

REPORTED CHRONIC DISEASE - KIDNEY/URINARY TRACT DISEASE AMONG THE EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	URINARY TRACT DISEASE
49	35	F	NURSE	66	82	9660	NEPHRLITHIASIS
50	31	M	DOCTOR	75	82	1610	NEPHRLITHIASIS
51	32	F	OTHER	78	82	4140	NEPHRLITHIASIS
52	56	M	DOCTOR	57	82	9752	NEPHRLITHIASIS
53	57	F	NURSE	57	82	46000	NEPHRLITHIASIS
54	44	M	DOCTOR	67	82	37536	NEPHRLITHIASIS
55	58	M	DOCTOR	50	55		NEPHRLITHIASIS
56	32	M	DOCTOR	77	81	3680	NEPHRLITHIASIS
57	42	M	DOCTOR	66	72	4416	NEPHRLITHIASIS
58	46	F	NURSE	58	69	12880	NEPHRLITHIASIS
59	55	M	NURSE	65	82	31280	NEPHRLITHIASIS
60	54	M	DOCTOR	56	83	24840	NEPHRLITHIASIS
61	54	F	NURSE	61	83	33638	NEPHRLITHIASIS
62	29	F	NURSE	73	83	14089	NEPHRLITHIASIS
63	45	F	NURSE	61	83	22655	NEPHRLITHIASIS
64	58	M	DOCTOR	53	82	26358	NEPHRLITHIASIS
65	32	M	DOCTOR	75	82	3174	NEPHRLITHIASIS
66	53	M	DOCTOR	80	82		NEPHRLITHIASIS
67	62	M	DOCTOR	41	82	37720	NEPHRLITHIASIS
68	34	M	DOCTOR	73	82	5382	NEPHRLITHIASIS
69	41	M	DOCTOR	64	82	2484	NEPHRLITHIASIS
70	44	M	DOCTOR	67	73	1311	NEPHRLITHIASIS
71	51	M	DOCTOR				NEPHRLITHIASIS
72	44	F	NURSE	60	63	770	NEPHRLITHIASIS
73	48	M	DOCTOR	64	68	12420	NEPHRLITHIASIS
74	59	M	DOCTOR	50	84	920	NEPHRLITHIASIS
75	34	F	NURSE	73	82	3881	NEPHRLITHIASIS
76	34	F	NURSE	81	82	832	NEPHRLITHIASIS
77	47	F	OTHER	70	82	5520	NEPHRLITHIASIS
78	61	F	NURSE	39	82	9065	NEPHRLITHIASIS
79	55	M	DOCTOR	53	59	17572	NEPHRLITHIASIS
80	30	F	NURSE	74	82	13800	NEPHRLITHIASIS
81	39	M	DOCTOR	68	83	4140	NEPHRLITHIASIS
82	32	M	NURSE	72	82	5255	NEPHRLITHIASIS
83	56	M	DOCTOR	50	82	4991	NEPHRLITHIASIS
84	62	F	OTHER	41	45	5605	NEPHRLITHIASIS
85	34	M	DOCTOR	76	77	1380	NEPHRLITHIASIS
86	26	M	DOCTOR	79	82	262	NEPHRLITHIASIS
87	37	F	NURSE	64	82	29935	NEPHRLITHIASIS
88	43	F	NURSE	58	82	32661	NEPHRLITHIASIS
89	32	F	NURSE	74	82	10005	NEPHRLITHIASIS
90	55	M	DOCTOR	42	82	2760	NEPHRLITHIASIS
91	39	F	NURSE	63	82	26150	NEPHRLITHIASIS
92	32	F	NURSE	69	82	17160	NEPHRLITHIASIS
93	54	M	DOCTOR	55	82	5658	NEPHRLITHIASIS
94	28	M	DOCTOR	79	84	2062	NEPHRLITHIASIS
95	30	M	DOCTOR	59	59	334	NEPHRLITHIASIS
96	40	M	DOCTOR	69	70	418	NEPHRLITHIASIS

REPORTED CHRONIC DISEASE - KIDNEY/URINARY TRACT DISEASE AMONG THE EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	URINARY TRACT DISEASE
97	29	F	NURSE	71	81	3024	NEPHRLITHIASIS
98	35	M	OTHER	79	81	4313	NEPHRLITHIASIS
99	29	F	NURSE	78	83	8021	NEPHRLITHIASIS
100	46	M	DOCTOR	58	75	6946	NEPHRLITHIASIS
101	47	M	DOCTOR	67	73	1104	NEPHRLITHIASIS
102	57	M	DOCTOR	55	56		NEPHRLITHIASIS
103	50	M	DOCTOR	58	60	3036	NEPHRLITHIASIS
104	56	M	DOCTOR	57	83	28520	NEPHRLITHIASIS
105	39	F	NURSE	65	83	51520	NEPHRLITHIASIS
106	59	M	DOCTOR	49	83	29084	NEPHRLITHIASIS
107	66	M	DOCTOR	43	80	920	NEPHRLITHIASIS
108	33	F	NURSE	71	83	15456	NEPHRLITHIASIS
109	47	M	DOCTOR	68	83	19596	NEPHRLITHIASIS
110	57	M	DOCTOR	50	83	36800	NEPHRLITHIASIS
111	49	F	NURSE	60	82	34040	NEPHROTIC SYNDR
112	31	F	NURSE	76	82	10350	NEPHROTIC SYNDR
113	34	M	DOCTOR	72	83	2484	NEPHROTIC SYNDR
114	55	M	DOCTOR	57	83	36869	OBSTRUCTION
115	27	F	NURSE	74	81	45	OBSTRUCTION
116	34	F	NURSE	74	82	7763	RENAL TUBULE
117	32	F	NURSE	70	82	14952	RENAL TUBULE
118	51	F	NURSE	50	50	462	UNCLASSIFIABLE
119	43	F	NURSE	58	82	20223	UNCLASSIFIABLE
120	38	F	NURSE	64	82	15468	UNCLASSIFIABLE
121	56	F	NURSE	58	82	27117	UNCLASSIFIABLE
122	44	F	NURSE	61	83	38995	UNCLASSIFIABLE
123	40	F	NURSE	62	82	29732	UNCLASSIFIABLE
124	29	F	NURSE	73	82	8928	UNCLASSIFIABLE
125	48	M	DOCTOR	59	82	26450	UNCLASSIFIABLE
126	48	F	NURSE	60	82	17570	UNCLASSIFIABLE
127	50	M	DOCTOR	57	83	18216	UNCLASSIFIABLE
128	36	M	OTHER	76	82	3450	UNCLASSIFIABLE
129	52	F	OTHER	75	82	12075	UNCLASSIFIABLE
130	32	F	NURSE	68	81	21620	UNCLASSIFIABLE
131	67	M	DOCTOR	41	45	460	UNCLASSIFIABLE
132	41	F	NURSE	78	82	4775	UNCLASSIFIABLE
133	32	M	OTHER	73	82	2128	UNCLASSIFIABLE
134	48	M	DOCTOR	60	65	12144	UNCLASSIFIABLE
135	44	M	DOCTOR	61	62	116	UNCLASSIFIABLE
136	57	M	DOCTOR	50	82	8579	UNCLASSIFIABLE
137	56	F	OTHER	73	82	4830	UNCLASSIFIABLE
138	41	F	NURSE	61	81	28062	UNCLASSIFIABLE
139	60	M	DOCTOR	56	66	4600	UNCLASSIFIABLE
140	35	F	NURSE	67	83	11435	UNCLASSIFIABLE
141	53	F	NURSE	52	83	33120	UNCLASSIFIABLE
142	34	F	NURSE	74	82	14720	URINARY TRACT
143	53	M	DOCTOR	54	55	576	URINARY TRACT
144	43	F	OTHER	81	82	1725	URINARY TRACT

REPORTED CHRONIC DISEASE - KIDNEY/URINARY TRACT DISEASE AMONG THE EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	URINARY TRACT DISEASE
145	38	F	NURSE	66	82	14120	URINARY TRACT
146	40	F	NURSE	63	82	31050	URINARY TRACT
147	22	F	OTHER	80	82	690	URINARY TRACT
148	67	M	DOCTOR	48	83	19320	URINARY TRACT
149	35	F	NURSE	68	68	240	URINARY TRACT
150	44	F	NURSE	57	82	26392	URINARY TRACT
151	39	F	NURSE	71	82	18975	URINARY TRACT
152	41	F	NURSE	61	82	17610	URINARY TRACT
153	34	F	NURSE	67	82	18635	URINARY TRACT
154	33	F	NURSE	69	69	462	URINARY TRACT
155	41	F	NURSE	58	82	18699	URINARY TRACT
156	29	F	NURSE	80	82	2588	URINARY TRACT
157	31	F	NURSE	78	82	4186	URINARY TRACT
158	35	F	NURSE	66	66	400	URINARY TRACT
159	44	F	OTHER	56	58	22908	URINARY TRACT
160	31	F	NURSE	80	82	2760	URINARY TRACT
161	40	F	NURSE	65	82	29325	URINARY TRACT
162	60	F	NURSE	43	82	47242	URINARY TRACT
163	38	F	NURSE	74	82	14720	URINARY TRACT
164	44	F	NURSE	58	82	15182	URINARY TRACT
165	43	F	NURSE	57	82	40480	URINARY TRACT
166	31	F	NURSE	72	82	12880	URINARY TRACT
167	33	F	OTHER	67	82	1682	URINARY TRACT
168	27	F	OTHER	73	82	671	URINARY TRACT
169	24	F	NURSE	80	82	3888	URINARY TRACT
170	31	F	NURSE	71	82	16560	URINARY TRACT
171	28	F	OTHER	76	83	1932	URINARY TRACT
172	33	F	NURSE	72	83	18216	URINARY TRACT
173	39	F	NURSE	62	83	6215	URINARY TRACT
174	47	F	OTHER	56	83	18227	URINARY TRACT
175	28	F	OTHER	81	83	738	URINARY TRACT
176	29	F	NURSE	77	82	4514	URINARY TRACT
177	31	F	NURSE	70	82	7452	URINARY TRACT
178	29	F	NURSE	70	82	6492	URINARY TRACT
179	34	F	NURSE	71	82	17250	URINARY TRACT
180	51	F	OTHER	72	82	4830	URINARY TRACT
181	36	F	NURSE	67	81	17480	URINARY TRACT
182	41	F	NURSE	66	81	27600	URINARY TRACT
183	33	M	NURSE	79	81	3148	URINARY TRACT
184	43	F	NURSE	58	81	22678	URINARY TRACT
185	40	F	DOCTOR	72	72	1242	URINARY TRACT
186	35	F	NURSE	78	82	8464	URINARY TRACT
187	68	M	DOCTOR	41	82	28060	URINARY TRACT
188	37	F	DOCTOR	73	82	2864	URINARY TRACT
189	50	M	DOCTOR	58	82	36805	URINARY TRACT
190	31	F	NURSE	73	82	15525	URINARY TRACT
191	35	F	DOCTOR	76	82	6256	URINARY TRACT
192	50	F	NURSE	79	82	5175	URINARY TRACT

REPORTED CHRONIC DISEASE - KIDNEY/URINARY TRACT DISEASE AMONG THE EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	URINARY TRACT DISEASE
193	38	F	NURSE	62	82	20010	URINARY TRACT
194	33	M	DOCTOR	74	76		URINARY TRACT
195	36	F	NURSE	68	82	17509	URINARY TRACT
196	57	M	DOCTOR	50	84	62560	URINARY TRACT
197		M	DOCTOR				URINARY TRACT
198	35	F	NURSE	72	83	19090	URINARY TRACT
199	55	M	DOCTOR	53	84	8832	URINARY TRACT
200	42	F	OTHER	59	82	2622	URINARY TRACT
201	39	F	NURSE	61	82	2813	URINARY TRACT
202	26	F	NURSE	75	82	9252	URINARY TRACT
203	27	F	OTHER	75	82	322	URINARY TRACT
204	27	F	OTHER	75	82	414	URINARY TRACT
205	31	F	NURSE	78	82	241	URINARY TRACT
206	34	F	NURSE	68	81	22080	URINARY TRACT
207	29	F	NURSE	74	81	414	URINARY TRACT
208	35	F	NURSE	67	81	20729	URINARY TRACT
209	30	F	NURSE	72	81	522	URINARY TRACT
210	40	F	NURSE	72	81	17250	URINARY TRACT
211	55	F	OTHER	45	81	26105	URINARY TRACT
212	33	F	NURSE	70	82	22542	URINARY TRACT
213	31	F	NURSE	71	82	3080	URINARY TRACT
214	35	F	NURSE	68	82	14214	URINARY TRACT
215	63	M	OTHER	72	82	17250	URINARY TRACT
216	26	F	NURSE	80	82	1725	URINARY TRACT
217	32	F	NURSE	70	82	11389	URINARY TRACT
218	33	F	NURSE	71	82	15870	URINARY TRACT
219	54	M	DOCTOR	57	82	9200	URINARY TRACT
220	29	F	NURSE	73	82	16088	URINARY TRACT
221	39	F	NURSE	63	82	16503	URINARY TRACT
222	59	M	DOCTOR	43	82	2691	URINARY TRACT
223	40	F	NURSE	61	82	5618	URINARY TRACT
224	40	F	NURSE	62	82	36800	URINARY TRACT
225	36	F	NURSE	66	82	14730	URINARY TRACT
226	56	F	OTHER	75	82	10120	URINARY TRACT
227	36	F	OTHER	66	82	3450	URINARY TRACT
228	40	F	NURSE	59	82	27877	URINARY TRACT
229	39	F	NURSE	62	82	21353	URINARY TRACT
230	53	F	NURSE	47	82	32396	URINARY TRACT
231	32	F	NURSE	70	82	11359	URINARY TRACT
232	33	F	NURSE	69	76	3360	URINARY TRACT
233	29	F	NURSE	73	82	11264	URINARY TRACT
234	37	F	NURSE	63	82	18376	URINARY TRACT
235	35	F	NURSE	68	68	480	URINARY TRACT
236	42	F	NURSE	59	63	3784	URINARY TRACT
237	33	F	NURSE	69	69		URINARY TRACT
238	46	F	NURSE	55	82	3802	URINARY TRACT
239	29	F	NURSE	73	80	4063	URINARY TRACT
240	42	F	NURSE	60	82	16104	URINARY TRACT

REPORTED CHRONIC DISEASE - KIDNEY/URINARY TRACT DISEASE AMONG THE EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	URINARY TRACT DISEASE
241	53	F	OTHER	73	82	15525	URINARY TRACT
242	36	F	NURSE	65	65	462	URINARY TRACT
243	37	F	NURSE	77	81	8625	URINARY TRACT
244	20	F	NURSE	79	81	2070	URINARY TRACT
245	28	F	NURSE	78	83	2300	URINARY TRACT
246	30	F	NURSE	77	80	5520	URINARY TRACT
247	22	F	OTHER	81	82	69	URINARY TRACT
248	37	F	NURSE	65	82	28370	URINARY TRACT
249	23	F	OTHER	79	82	828	URINARY TRACT
250	35	F	NURSE	68	83	23920	URINARY TRACT
251	41	F	NURSE	61	83	26480	URINARY TRACT
252	36	F	NURSE	68	83	16514	URINARY TRACT
253	35	F	NURSE	74	83	12420	URINARY TRACT
254	36	F	NURSE	70	83	20930	URINARY TRACT
255	58	F	OTHER	73	81	15525	URINARY TRACT
256	51	F	NURSE	63	78	13800	URINARY TRACT
257	34	F	DOCTOR	75	76	132	URINARY TRACT
258	27	F	NURSE	75	82	12880	URINARY TRACT
259	53	F	NURSE	51	51	936	URINARY TRACT

REPORTED CHRONIC DISEASE - KIDNEY/URINARY TRACT DISEASE AMONG THE NON-EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	URINARY TRACT DISEASE
1	31	M	OTHER	NOT APPLICABLE			ASYMP OBSTRUCT
2	38	F	DOCTOR				ASYMP OBSTRUCT
3	45	F	OTHER				NEPHRLITHIASIS
4	33	M	NURSE				NEPHRLITHIASIS
5	27	F	NURSE				NEPHRLITHIASIS
6	28	F	NURSE				NEPHRLITHIASIS
7	34	M	OTHER				NEPHRLITHIASIS
8	42	F	OTHER				NEPHRLITHIASIS
9	27	M	DOCTOR				NEPHRLITHIASIS
10	39	M	OTHER				NEPHRLITHIASIS
11	59	F	OTHER				NEPHRLITHIASIS
12	41	M	DOCTOR				NEPHRLITHIASIS
13	56	M	OTHER				NEPHRLITHIASIS
14	41	M	DOCTOR				NEPHRLITHIASIS
15	48	M	OTHER				NEPHRLITHIASIS
16	33	F	NURSE				NEPHRLITHIASIS
17	37	M	OTHER				NEPHRLITHIASIS
18	47	M	DOCTOR				NEPHRLITHIASIS
19	38	M	OTHER				NEPHRLITHIASIS
20	38	M	NURSE				NEPHRLITHIASIS
21	61	M	OTHER				NEPHRLITHIASIS
22	36	F	NURSE				NEPHRLITHIASIS
23	48	M	DOCTOR				NEPHRLITHIASIS
24	30	F	OTHER				NEPHRLITHIASIS
25	32	F	NURSE				NEPHRLITHIASIS
26	56	M	DOCTOR				NEPHRLITHIASIS
27	31	M	OTHER				NEPHRLITHIASIS
28	64	M	DOCTOR				NEPHRLITHIASIS
29	57	M	DOCTOR				NEPHRLITHIASIS
30	34	M	DOCTOR				NEPHRLITHIASIS
31	38	F	OTHER				NEPHRLITHIASIS
32	36	F	OTHER				NEPHROTIC SYNDR
33	35	F	NURSE				OBSTRUCTION
34	19	F	NURSE				UNCLASSIFIABLE
35	38	M	OTHER				UNCLASSIFIABLE
36	32	F	OTHER				UNCLASSIFIABLE
37	27	F	NURSE				UNCLASSIFIABLE
38	33	F	OTHER				UNCLASSIFIABLE
39	36	F	OTHER				UNCLASSIFIABLE
40	30	F	NURSE				UNCLASSIFIABLE
41	22	F	NURSE				URINARY TRACT
42	24	F	OTHER				URINARY TRACT
43	24	F	NURSE				URINARY TRACT
44	23	F	NURSE				URINARY TRACT
45	29	F	NURSE				URINARY TRACT
46	31	F	NURSE				URINARY TRACT
47	39	F	OTHER				URINARY TRACT
48	20	F	NURSE				URINARY TRACT

REPORTED CHRONIC DISEASE - KIDNEY/URINARY TRACT DISEASE AMONG THE NON-EXPOSED RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	URINARY TRACT DISEASE
49	29	M	OTHER	NOT APPLICABLE			URINARY TRACT
50	30	F	NURSE				URINARY TRACT
51	24	F	OTHER				URINARY TRACT
52	27	F	NURSE				URINARY TRACT
53	34	F	DOCTOR				URINARY TRACT
54	35	F	NURSE				URINARY TRACT
55	39	F	OTHER				URINARY TRACT
56	28	F	NURSE				URINARY TRACT
57	32	F	OTHER				URINARY TRACT
58	34	F	NURSE				URINARY TRACT
59	32	F	OTHER				URINARY TRACT
60	30	F	OTHER				URINARY TRACT
61	33	M	DOCTOR				URINARY TRACT
62	49	M	DOCTOR				URINARY TRACT
63	42	F	NURSE				URINARY TRACT
64	30	F	NURSE				URINARY TRACT
65	47	F	OTHER				URINARY TRACT
66	41	F	OTHER				URINARY TRACT
67	37	F	NURSE				URINARY TRACT
68	37	F	OTHER				URINARY TRACT
69	50	F	DOCTOR				URINARY TRACT
70	24	F	NURSE				URINARY TRACT
71	26	F	NURSE				URINARY TRACT
72	31	F	NURSE				URINARY TRACT
73	35	F	NURSE				URINARY TRACT
74	46	F	NURSE				URINARY TRACT
75	24	F	NURSE				URINARY TRACT
76	51	M	OTHER				URINARY TRACT

REPORTED CHRONIC DISEASE - KIDNEY/URINARY TRACT DISEASE AMONG THE RANDOM SAMPLE RESPONDENTS

LIST	AGE	SEX	OCCUPATION	1ST ANAS EXP YEAR	LAST ANAS EXP YEAR	TOTAL LIFE TIME ANAS EXP HRS	URINARY TRACT DISEASE
1	50	M	DOCTOR	59	83	46736	CHRON RENAL FAIL
2	62	M	DOCTOR	46	83	34086	NEPHRLITHIASIS
3	37	F	NURSE	70	82	15870	NEPHRLITHIASIS
4	34	F	NURSE	73	82	13800	NEPHRLITHIASIS
5	48	F	OTHER	75	83	5175	NEPHRLITHIASIS
6	62	M	DOCTOR	49	82	33350	NEPHRLITHIASIS
7	33	M	DOCTOR	74	81	1816	NEPHRLITHIASIS
8	44	M	DOCTOR	67	82	37536	NEPHRLITHIASIS
9	54	M	DOCTOR	56	83	24840	NEPHRLITHIASIS
10	41	M	DOCTOR	64	82	2484	NEPHRLITHIASIS
11	61	F	NURSE	39	82	9065	NEPHRLITHIASIS
12	30	F	NURSE	74	82	13800	NEPHRLITHIASIS
13	39	M	DOCTOR	68	83	4140	NEPHRLITHIASIS
14	32	F	NURSE	69	82	17160	NEPHRLITHIASIS
15	54	M	DOCTOR	55	82	5658	NEPHRLITHIASIS
16	29	F	NURSE	71	81	3024	NEPHRLITHIASIS
17	56	M	DOCTOR	57	83	28520	NEPHRLITHIASIS
18	33	F	NURSE	71	83	15456	NEPHRLITHIASIS
19	47	M	DOCTOR	68	83	19596	NEPHRLITHIASIS
20	57	M	DOCTOR	50	83	36800	NEPHRLITHIASIS
21	32	F	NURSE	70	82	14952	RENAL TUBULE
22	43	F	NURSE	58	82	20223	UNCLASSIFIABLE
23	29	F	NURSE	73	82	8928	UNCLASSIFIABLE
24	48	M	DOCTOR	60	65	12144	UNCLASSIFIABLE
25	41	F	NURSE	61	82	17610	URINARY TRACT
26	34	F	NURSE	67	82	18635	URINARY TRACT
27	38	F	NURSE	74	82	14720	URINARY TRACT
28	43	F	NURSE	57	82	40480	URINARY TRACT
29	31	F	NURSE	71	82	16560	URINARY TRACT
30	28	F	OTHER	76	83	1932	URINARY TRACT
31	29	F	NURSE	70	82	6492	URINARY TRACT
32	41	F	NURSE	66	81	27600	URINARY TRACT
33	43	F	NURSE	58	81	22678	URINARY TRACT
34	35	F	NURSE	78	82	8464	URINARY TRACT
35	35	F	DOCTOR	76	82	6256	URINARY TRACT
36	57	M	DOCTOR	50	84	62560	URINARY TRACT
37	55	M	DOCTOR	53	84	8832	URINARY TRACT
38	39	F	NURSE	61	82	2813	URINARY TRACT
39	27	F	OTHER	75	82	414	URINARY TRACT
40	29	F	NURSE	74	81	414	URINARY TRACT
41	40	F	NURSE	72	81	17250	URINARY TRACT
42	33	F	NURSE	70	82	22542	URINARY TRACT
43	33	F	NURSE	71	82	15870	URINARY TRACT
44	36	F	OTHER	66	82	3450	URINARY TRACT
45	39	F	NURSE	62	82	21353	URINARY TRACT
46	42	F	NURSE	60	82	16104	URINARY TRACT
47	37	F	NURSE	65	82	28370	URINARY TRACT

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
1		08	U	30	M	RESPIRAT. OTHER		
2		08	U	31	F	RESPIRAT. OTHER		
3	F	51	N	33	F	ACHONDROPLASIA		
4	F	51	N	35	F	ACHONDROPLASIA		
5	F	48	N	38	M	AGENESIS OF LUNG	CNTL.NERV. OTHER	
6	F	42	U	33	F	ANENCEPHALY		
7	F	44	N	27	F	ARTRIAL SEPTAL	CLEFT PALATE/LIP	
8	F	35	N	22	F	ARTRIAL SEPTAL	VENTRICULAR SEPT	PATENT DUCTUS
9	F	40	N	24	F	ARTRIAL SEPTAL		
10	F	33	N	32	M	ARTRIAL SEPTAL	VENTRICULAR SEPT	MUSCULOSK. OTHER
11	F	40	N	26	M	ARTRIAL SEPTAL		
12	F	29	U	27	F	BIRTHMARK		
13	F	56	N	41	F	BIRTHMARK		
14	F	35	N	30	F	BIRTHMARK		
15	F	35	N	28	M	BIRTHMARK		
16	F	41	N	23	F	BIRTHMARK		
17	F	54	N	34	M	BIRTHMARK		
18	F	44	N	31	M	BIRTHMARK		
19	F	41	N	27	F	BIRTHMARK		
20	F	38	N	25	M	BIRTHMARK	RESPIRAT. OTHER	
21	F	38	N	34	F	BIRTHMARK	RESPIRAT. OTHER	
22	F	34	N	26	F	BIRTHMARK		
23	F	29	N	23	F	BIRTHMARK		
24	F	43	N	26	F	BIRTHMARK		
25	F	27	N	26	F	BIRTHMARK		
26	F	31	N	25	M	BIRTHMARK		
27	F	31	N	29	M	BIRTHMARK		
28	F	32	N	27	F	BIRTHMARK		
29	F	28	N	25	F	BIRTHMARK		
30	F	39	N	33	F	BIRTHMARK		
31	F	44	N	23	M	BIRTHMARK		
32	F	44	N	25	M	BIRTHMARK		
33	F	42	N	28	M	BIRTHMARK		
34	F	44	N	36	M	BIRTHMARK		
35	F	40	N	23	F	BIRTHMARK		
36	F	40	N	28	M	BIRTHMARK		
37	F	40	N	32	M	BIRTHMARK		
38	F	24	N	20	F	BIRTHMARK		
39	F	49	N	28	M	BIRTHMARK		
40	F	49	U	33	M	BIRTHMARK		
41	F	36	N	27	F	BIRTHMARK		
42	F	45	N	35	M	BIRTHMARK		
43	F	50	U	30	M	BIRTHMARK		
44	F	31	N	28	F	BIRTHMARK		
45	F	31	N	24	F	BIRTHMARK		
46	F	45	N	29	F	BIRTHMARK		
47	F	37	N	32	M	BIRTHMARK		
48	F	34	N	32	F	BIRTHMARK		
49	F	30	N	29	M	BIRTHMARK		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT WOES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
50	F	50	N	27	F	BIRTHMARK		
51	F	28	N	23	M	BIRTHMARK		
52	F	41	N	29	M	BIRTHMARK		
53	F	35	N	24	M	BIRTHMARK		
54	F	35	N	32	M	BIRTHMARK		
55	F	32	N	31	F	BIRTHMARK		
56	F	34	N	30	F	BIRTHMARK		
57	F	42	N	24	F	BIRTHMARK		
58	F	39	N	27	M	BIRTHMARK		
59	F	30	N	25	F	BIRTHMARK		
60	F	32	N	29	F	BIRTHMARK		
61	F	42	N	21	M	BIRTHMARK		
62	F	42	N	27	F	BIRTHMARK		
63	F	42	N	30	F	BIRTHMARK		
64	F	35	N	26	F	BIRTHMARK		
65	F	35	N	27	M	BIRTHMARK		
66	F	32	N	23	F	BIRTHMARK		
67	F	55	U	32	F	BIRTHMARK		
68	F	35	N	23	F	BIRTHMARK		
69	F	29	N	28	M	BIRTHMARK		
70	F	27	N	24	M	BIRTHMARK		
71	F	40	N	26	M	BIRTHMARK		
72	F	50	U	28	F	BIRTHMARK		
73	F	32	N	27	M	BIRTHMARK		
74	F	31	U	26	M	BIRTHMARK		
75	F	43	N	27	M	BIRTHMARK		
76	F	29	N	28	F	BIRTHMARK		
77	F	29	N	27	M	BIRTHMARK		
78	F	34	U	33	F	BIRTHMARK		
79	F	34	N	27	M	BIRTHMARK		
80	F	31	N	29	F	BIRTHMARK	SKIN, OTHER	MUSCULOSK, OTHER
81	F	40	N	27	F	BIRTHMARK		
82	F	41	N	23	M	BIRTHMARK		
83	F	41	N	25	F	BIRTHMARK		
84	F	37	N	31	F	BIRTHMARK		
85	F	41	N	24	M	BIRTHMARK		
86	F	41	N	26	F	BIRTHMARK		
87	F	30	N	28	M	BIRTHMARK		
88	F	33	N	29	M	BIRTHMARK		
89	F	29	N	26	F	BIRTHMARK		
90	F	39	N	22	F	BIRTHMARK		
91	F	39	N	26	F	BIRTHMARK		
92	F	53	N	29	F	BIRTHMARK		
93	F	30	N	25	F	BIRTHMARK		
94	F	35	N	24	M	BIRTHMARK		
95	F	45	N	23	F	BIRTHMARK		
96	F	45	N	24	F	BIRTHMARK		
97	F	45	N	20	F	BIRTHMARK		
98	F	45	N	31	M	BIRTHMARK		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT DOES ADM	RESPONDENT DOCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
99	F	45	N	33	M	BIRTHMARK		
100	F	29	N	28	M	BIRTHMARK		
101	F	48	N	26	M	BIRTHMARK		
102	F	33	N	23	M	BIRTHMARK		
103	F	34	U	32	F	BIRTHMARK		
104	F	34	U	31	F	BIRTHMARK		
105	F	49	U	26	F	BIRTHMARK		
106	F	31	N	26	F	BIRTHMARK		
107	F	27	N	26	F	BIRTHMARK		
108	F	40	N	25	M	BIRTHMARK		
109	F	36	N	31	F	BIRTHMARK		
110	F	27	U	22	M	BIRTHMARK		
111	F	47	N	27	M	BIRTHMARK		
112	F	34	N	25	M	BIRTHMARK		
113	F	31	N	31	F	BIRTHMARK		
114	F	44	N	36	M	CARDIOV. OTHER		
115	F	44	N	37	M	CARDIOV. OTHER		
116	F	32	U	33	F	CARDIOV. OTHER		
117	F	64	N	41	F	CARDIOV. OTHER		
118	F	34	N	26	F	CARDIOV. OTHER		
119	F	38	U	26	F	CARDIOV. OTHER		
120	F	38	U	28	M	CARDIOV. OTHER		
121	F	46	U	26	M	CARDIOV. OTHER	BIRTHMARK	
122	F	34	N	25	F	CARDIOV. OTHER		
123	F	42	N	32	M	CARDIOV. OTHER		
124	F	40	N	30	F	CARDIOV. OTHER		
125	F	49	N	35	M	CARDIOV. OTHER		
126	F	58	N	28	F	CARDIOV. OTHER		
127	F	58	N	30	M	CARDIOV. OTHER		
128	F	51	N	22	M	CARDIOV. OTHER	DIAPHRAG. HERNIA MUSCULOSK. OTHER	
129	F	38	U	31	F	CARDIOV. OTHER		
130	F	36	N	32	F	CARDIOV. OTHER		
131	F	31	N	23	M	CARDIOV. OTHER		
132	F	31	N	26	M	CARDIOV. OTHER		
133	F	53	U	26	M	CARDIOV. OTHER		
134	F	50	N	23	M	CARDIOV. OTHER	CNTL.NERV. OTHER	
135	F	36	N	30	F	CARDIOV. OTHER		
136	F	34	11	36	F	CARDIOV. OTHER		
137	F	29	N	28	M	CARDIOV. OTHER		
138	F	40	N	22	M	CARDIOV. OTHER		
139	F	60	N	33	F	CARDIOV. OTHER		
140	F	30	N	30	M	CARDIOV. OTHER		
141	F	62	U	21	F	CARDIOV. OTHER		
142	F	62	U	28	M	CARDIOV. OTHER		
143	F	33	N	31	M	CARDIOV. OTHER		
144	F	32	N	27	F	CARDIOV. OTHER		
145	F	34	N	28	M	CARDIOV. OTHER		
146	F	41	N	21	M	CARDIOV. OTHER		
147	F	41	N	27	F	CARDIOV. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
148	F	30	N	28	F	CAVERNOUS HEMANG		
149	F	45	N	32	F	CAVERNOUS HEMANG		
150	F	36	N	23	M	CAVERNOUS HEMANG		
151	F	36	N	25	M	CAVERNOUS HEMANG		
152	F	36	N	28	F	CAVERNOUS HEMANG		
153	F	40	N	25	M	CAVERNOUS HEMANG		
154	F	40	N	27	F	CAVERNOUS HEMANG		
155	F	40	N	27	F	CAVERNOUS HEMANG		
156	F	43	U	24	M	CAVERNOUS HEMANG	NEVUS	
157	F	40	N	29	F	CAVERNOUS HEMANG		
158	F	34	N	28	M	CAVERNOUS HEMANG		
159	F	33	U	27	M	CAVERNOUS HEMANG		
160	F	33	U	31	M	CAVERNOUS HEMANG		
161	F	30	N	23	F	CLEFT PALATE/LIP	ANENCEPHALY	
162	F	43	N	32	F	CLEFT PALATE/LIP	UROGENITAL OTHER	
163	F	33	N	29	M	CLEFT PALATE/LIP		
164	F	31	U	27	F	CLEFT PALATE/LIP		
165	F	28	U	27	M	CLEFT PALATE/LIP		
166	F	29	N	27	M	CLEFT PALATE/LIP		
167	F	37	U	34	M	CLEFT PALATE/LIP		
168	F	34	N	24	M	CLEFT PALATE/LIP		
169	F	34	N	29	F	CLEFT PALATE/LIP		
170	F	34	N	25	M	CLEFT PALATE/LIP		
171	F	43	N	24	F	CLEFT PALATE/LIP		
172	F	30	N	33	M	CNTL.NERV. OTHER		
173	F	33	N	34	F	CNTL.NERV. OTHER		
174	F	44	N	27	M	CNTL.NERV. OTHER	SKIN. OTHER	
175	F	44	N	32	M	CNTL.NERV. OTHER		
176	F	30	N	25	M	CNTL.NERV. OTHER	MUSCULOSK. OTHER	GASTRO INT.OTHER
177	F	48	N	36	F	CNTL.NERV. OTHER		
178	F	32	N	24	F	CNTL.NERV. OTHER		
179	F	34	N	22	F	CNTL.NERV. OTHER	HYDROCEPHALUS	RESPIRAT. OTHER
180	F	34	N	27	M	CNTL.NERV. OTHER		
181	F	49	N	28	F	CNTL.NERV. OTHER		
182	F	40	N	20	M	CNTL.NERV. OTHER		
183	F	48	N	22	M	CNTL.NERV. OTHER	CAVERNOUS HEMANG	
184	F	33	N	33	F	CNTL.NERV. OTHER		
185	F	33	N	34	M	CNTL.NERV. OTHER		
186	F	34	N	27	F	CNTL.NERV. OTHER		
187	F	44	N	30	M	CNTL.NERV. OTHER		
188	F	38	N	29	M	CNTL.NERV. OTHER		
189	F	37	N	28	F	CNTL.NERV. OTHER		
190	F	43	U	25	M	CNTL.NERV. OTHER		
191	F	43	U	25	M	CNTL.NERV. OTHER		
192	F	31	N	21	M	DIAPHRAG. HERNIA	SKIN. OTHER	
193	F	27	U	25	F	DIAPHRAG. HERNIA		
194	F	34	N	21	M	GASTRO INT.OTHER	UNDESC. TESTICLE	
195	F	32	N	29	M	GASTRO INT.OTHER		
196	F	35	N	34	M	GASTRO INT.OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPON-DENT	RESPON-DENT AGE AT QUES ADM	RESPON-DENT QUCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
197	F	41	N	24	M	GASTRO INT.OTHER		
198	F	34	N	31	M	GASTRO INT.OTHER		
199	F	45	N	30	M	GASTRO INT.OTHER	UROGENITAL OTHER	
200	F	42	N	30	M	GASTRO INT.OTHER		
201	F	53	N	33	F	GASTRO INT.OTHER		
202	F	31	N	26	M	GASTRO INT.OTHER	BIRTHMARK	
203	F	35	N	23	M	GASTRO INT.OTHER		
204	F	32	N	24	F	GASTRO INT.OTHER		
205	F	36	D	27	M	GASTRO INT.OTHER		
206	F	36	D	29	F	GASTRO INT.OTHER	VENTRICULAR SEPT	CARDIOV. OTHER
207	F	34	N	30	F	GASTRO INT.OTHER	RESPIRAT. OTHER	SKIN. OTHER
208	F	42	N	29	F	GASTRO INT.OTHER		
209	F	48	N	28	M	GASTRO INT.OTHER		
210	F	48	N	29	F	GASTRO INT.OTHER		
211	F	36	N	34	M	GASTRO INT.OTHER		
212	F	29	N	28	F	GASTRO INT.OTHER		
213	F	41	N	25	F	GASTRO INT.OTHER		
214	F	44	N	26	M	GASTRO INT.OTHER		
215	F	40	N	23	M	GASTRO INT.OTHER		
216	F	28	U	26	M	GASTRO INT.OTHER		
217	F	32	U	21	M	GASTRO INT.OTHER		
218	F	48	N	36	M	HYDROCEPHALUS		
219	F	52	N	31	M	HYDROCEPHALUS	NEVUS	
220	F	31	N	24	M	HYPOSPADIAS		
221	F	38	N	22	M	HYPOSPADIAS		
222	F	38	N	25	F	HYPOSPADIAS		
223	F	40	N	27	M	HYPOSPADIAS		
224	F	32	N	25	M	HYPOSPADIAS		
225	F	42	N	25	M	HYPOSPADIAS		
226	F	34	N	23	M	HYPOSPADIAS		
227	F	40	N	23	M	HYPOSPADIAS		
228	F	31	N	28	M	HYPOSPADIAS	BIRTHMARK	
229	F	42	N	22	M	HYPOSPADIAS		
230	F	31	N	24	M	HYPOSPADIAS		
231	F	32	N	24	M	HYPOSPADIAS		
232	F	32	N	27	M	HYPOSPADIAS	UNDESC. TESTICLE	
233	F	40	N	27	M	HYPOSPADIAS		
234	F	48	N	29	M	HYPOSPADIAS		
235	F	36	N	20	M	HYPOSPADIAS		
236	F	55	N	34	F	IMPERFORATE ANUS	UNDESC. TESTICLE	MUSCULOSK. OTHER
237	F	33	N	28	M	LIMB AMPUTATION	GASTRO INT.OTHER	
238	F	40	N	32	M	MUSCULOSK. OTHER		
239	F	42	N	32	F	MUSCULOSK. OTHER		
240	F	33	N	27	M	MUSCULOSK. OTHER		
241	F	42	N	26	F	MUSCULOSK. OTHER		
242	F	34	N	25	F	MUSCULOSK. OTHER		
243	F	34	N	26	M	MUSCULOSK. OTHER		
244	F	40	N	34	F	MUSCULOSK. OTHER		
245	F	33	N	32	M	MUSCULOSK. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT QUCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
246	F	44	N	21	F	MUSCULOSK. OTHER		
247	F	54	N	26	F	MUSCULOSK. OTHER		
248	F	44	N	28	F	MUSCULOSK. OTHER		
249	F	40	N	23	M	MUSCULOSK. OTHER		
250	F	50	N	31	M	MUSCULOSK. OTHER		
251	F	31	N	23	M	MUSCULOSK. OTHER	BIRTHMARK	
252	F	28	N	27	M	MUSCULOSK. OTHER		
253	F	43	N	26	M	MUSCULOSK. OTHER	SPINA BIFIDA	HYDROCEPHALUS
254	F	39	N	25	F	MUSCULOSK. OTHER		
255	F	33	U	29	M	MUSCULOSK. OTHER		
256	F	47	N	29	F	MUSCULOSK. OTHER		
257	F	38	N	31	F	MUSCULOSK. OTHER		
258	F	38	N	34	F	MUSCULOSK. OTHER		
259	F	36	U	30	F	MUSCULOSK. OTHER		
260	F	32	N	25	M	MUSCULOSK. OTHER		
261	F	40	N	30	M	MUSCULOSK. OTHER		
262	F	37	U	32	M	MUSCULOSK. OTHER	SKIN. OTHER	
263	F	35	U	28	F	MUSCULOSK. OTHER		
264	F	31	N	23	F	MUSCULOSK. OTHER	NEVUS	
265	F	31	N	26	M	MUSCULOSK. OTHER	NEVUS	
266	F	31	N	30		MUSCULOSK. OTHER		
267	F	39	N	21	M	MUSCULOSK. OTHER	RESPIRAL. OTHER	
268	F	44	N	28	M	MUSCULOSK. OTHER		
269	F	31	U	30	M	MUSCULOSK. OTHER		
270	F	27	N	26	F	MUSCULOSK. OTHER		
271	F	28	N	26	M	MUSCULOSK. OTHER		
272	F	42	N	27	F	MUSCULOSK. OTHER		
273	F	31	N	28	F	MUSCULOSK. OTHER		
274	F	24	U	23	F	MUSCULOSK. OTHER		
275	F	50	U	34	M	MUSCULOSK. OTHER		
276	F	42	N	30	F	MUSCULOSK. OTHER		
277	F	36	N	23	M	MUSCULOSK. OTHER		
278	F	36	N	25	F	MUSCULOSK. OTHER		
279	F	43	N	26	F	MUSCULOSK. OTHER		
280	F	36	N	27	M	MUSCULOSK. OTHER		
281	F	36	N	32	M	MUSCULOSK. OTHER		
282	F	49	N	29	F	MUSCULOSK. OTHER		
283	F	29	N	27	M	MUSCULOSK. OTHER		
284	F	33	N	27	M	MUSCULOSK. OTHER	SKIN. OTHER	
285	F	37	N	27	M	MUSCULOSK. OTHER		
286	F	42	N	34	F	MUSCULOSK. OTHER	UROGENITAL OTHER	
287	F	43	N	32	M	MUSCULOSK. OTHER		
288	F	39	N	24	M	MUSCULOSK. OTHER		
289	F	32	N	25	F	MUSCULOSK. OTHER		
290	F	32	N	28	M	MUSCULOSK. OTHER		
291	F	32	N	27	F	MUSCULOSK. OTHER		
292	F	32	N	29	M	MUSCULOSK. OTHER		
293	F	31	N	28	M	MUSCULOSK. OTHER	UROGENITAL OTHER	
294	F	31	N	27	F	MUSCULOSK. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT QCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
295	F	36	N	23	M	MUSCULOSK. OTHER		
296	F	40	N	26	M	MUSCULOSK. OTHER		
297	F	30	N	35	F	MUSCULOSK. OTHER		
298	F	33	N	26	M	MUSCULOSK. OTHER		
299	F	47	N	26	F	MUSCULOSK. OTHER		
300	F	47	N	27	M	MUSCULOSK. OTHER		
301	F	43	N	29	M	MUSCULOSK. OTHER		
302	F	44	N	30	M	MUSCULOSK. OTHER		
303	F	35	N	32	F	MUSCULOSK. OTHER		
304	F	38	U	34	M	NEVUS		
305	F	38	N	23	F	NEVUS		
306	F	38	N	34	F	NEVUS		
307	F	36	U	32	F	NEVUS		
308	F	34	N	26	M	NEVUS		
309	F	38	N	21	M	NEVUS		
310	F	34	U	32	F	NEVUS		
311	F	35	N	31	F	NEVUS		
312	F	32	N	29	M	NEVUS		
313	F	33	N	24	M	NEVUS		
314	F	34	N	25	M	NEVUS		
315	F	34	N	29	F	NEVUS		
316	F	33	N	23	F	NEVUS		
317	F	33	N	27	F	NEVUS		
318	F	31	N	30	F	NEVUS		
319	F	32	N	30	M	NEVUS		
320	F	32	N	21	F	NEVUS		
321	F	36	N	26	M	NEVUS		
322	F	33	N	30	M	NEVUS		
323	F	38	N	33	F	NEVUS		
324	F	37	N	19	M	NEVUS		
325	F	43	U	28	F	NEVUS	CARDIOV. OTHER	
326	F	50	N	37	F	NEVUS	UROGENITAL OTHER	MUSCULOSK. OTHER
327	F	42	U	31	F	NEVUS		
328	F	45	U	29	F	NEVUS		
329	F	47	U	34	F	NEVUS		
330	F	41	N	29	M	NEVUS		
331	F	41	N	28	M	UMPHALOCOELE		
332	F	53	N	30	F	PATENT DUCTUS		
333	F	38	N	29	M	PATENT DUCTUS	CNTL.NERV. OTHER	
334	F	31	N	29	M	PATENT DUCTUS		
335	F	41	N	31	M	PATENT DUCTUS		
336	F	41	N	30	M	PATENT DUCTUS		
337	F	36	N	29	M	RESPIRAT. OTHER		
338	F	45	N	30	F	RESPIRAT. OTHER		
339	F	45	N	32	F	RESPIRAT. OTHER		
340	F	34	N	23	F	RESPIRAT. OTHER		
341	F	38	N	30	M	RESPIRAT. OTHER		
342	F	36	N	26	F	RESPIRAT. OTHER		
343	F	33	N	26	M	RESPIRAT. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT QUESN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
344	F	44	N	20	M	RESPIRAT. OTHER		
345	F	44	N	30	M	RESPIRAT. OTHER	UNDESC. TESTICLE	
346	F	39	N	20	M	RESPIRAT. OTHER	GASTRO INT.OTHER	
347	F	43	N	22	F	RESPIRAT. OTHER	SKIN, OTHER	UROGENITAL OTHER
348	F	43	N	24	M	RESPIRAT. OTHER	SKIN, OTHER	UROGENITAL OTHER
349	F	34	N	23	F	RESPIRAT. OTHER		
350	F	41	N	23	F	RESPIRAT. OTHER		
351	F	38	N	34	F	RESPIRAT. OTHER	BIRTHMARK	
352	F	40	N	26	F	RESPIRAT. OTHER		
353	F	27	N	27	F	RESPIRAT. OTHER		
354	F	39	N	25	M	RESPIRAT. OTHER	SKIN, OTHER	
355	F	39	N	31	M	RESPIRAT. OTHER		
356	F	49	N	27	M	RESPIRAT. OTHER		
357	F	39	N	23	M	RESPIRAT. OTHER	CNTL.NERV, OTHER	SKIN, OTHER
358	F	36	N	33	M	RESPIRAT. OTHER		
359	F	27	N	26	M	RESPIRAT. OTHER	UROGENITAL OTHER	
360	F	39	N	35	M	RESPIRAT. OTHER		
361	F	35	N	26	M	RESPIRAT. OTHER		
362	F	35	N	32	M	RESPIRAT. OTHER		
363	F	31	N	28	M	RESPIRAT. OTHER		
364	F	28	U	27	F	RESPIRAT. OTHER		
365	F	36	U	26	M	RESPIRAT. OTHER		
366	F	33	N	24	F	SKIN, OTHER		
367	F	48	N	22	F	SKIN, OTHER		
368	F	48	N	24	F	SKIN, OTHER		
369	F	30	N	27	F	SKIN, OTHER		
370	F	31	N	28	F	SKIN, OTHER		
371	F	31	N	30	F	SKIN, OTHER		
372	F	29	N	25	M	SKIN, OTHER		
373	F	39	N	23	F	SKIN, OTHER		
374	F	32	N	23	M	SKIN, OTHER		
375	F	32	N	26	M	SKIN, OTHER		
376	F	32	N	31	M	SKIN, OTHER		
377	F	33	N	31	M	SKIN, OTHER		
378	F	42	N	23	M	SKIN, OTHER		
379	F	32	N	22	F	SKIN, OTHER		
380	F	31	N	20	M	SKIN, OTHER		
381	F	31	N	25	F	SKIN, OTHER		
382	F	29	N	27	F	SKIN, OTHER		
383	F	33	N	19	M	SKIN, OTHER		
384	F	36	N	34	M	SKIN, OTHER	MUSCULOSK. OTHER	
385	F	35	U	32	F	SKIN, OTHER		
386	F	34	N	28	F	SKIN, OTHER		
387	F	33	N	22	M	SKIN, OTHER		
388	F	35	N	25	M	SKIN, OTHER		
389	F	36	U	28	F	SKIN, OTHER		
390	F	27	N	23	M	SKIN, OTHER		
391	F	44	N	22	M	SKIN, OTHER		
392	F	40	U	32	F	SKIN, OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
393	F	49	N	26	F	SPINA BIFIDA	HYDROCEPHALUS	
394	F	36	N	25	F	SPINA BIFIDA	HYDROCEPHALUS	
395	F	32	N	23	M	SPINA BIFIDA		
396	F	44	U	25	F	SPINA BIFIDA		
397	F	35	N	29	M	SYNDACTYLY		
398	F	47	N	39	M	UNDESC. TESTICLE		
399	F	38	N	32	M	UNDESC. TESTICLE		
400	F	35	N	27	M	UNDESC. TESTICLE		
401	F	44	N	27	M	UNDESC. TESTICLE		
402	F	50	N	31	M	UNDESC. TESTICLE		
403	F	44	N	32	M	UNDESC. TESTICLE		
404	F	33	N	28	M	UNDESC. TESTICLE	UROGENITAL OTHER	
405	F	40	N	21	M	UNDESC. TESTICLE		
406	F	37	N	25	M	UNDESC. TESTICLE		
407	F	50	N	26	M	UNDESC. TESTICLE		
408	F	42	D	25	M	UNDESC. TESTICLE		
409	F	31	N	25	M	UNDESC. TESTICLE		
410	F	40	N	26	M	UNDESC. TESTICLE	MUSCULOSK. OTHER	
411	F	24	N	24	M	UNDESC. TESTICLE		
412	F	26	N	23	M	UNDESC. TESTICLE		
413	F	35	N	26	M	UNDESC. TESTICLE		
414	F	45	N	30	M	UNDESC. TESTICLE		
415	F	40	N	28	M	UNDESC. TESTICLE	BIRTHMARK	
416	F	33	N	26	M	UNDESC. TESTICLE	BIRTHMARK	
417	F	41	N	25	M	UNDESC. TESTICLE		
418	F	43	N	29	M	UNDESC. TESTICLE		
419	F	50	N	29	M	UNDESC. TESTICLE		
420	F	38	N	23	M	UNDESC. TESTICLE		
421	F	33	N	23	M	UNDESC. TESTICLE		
422	F	42	N	27	F	UROGENITAL OTHER		
423	F	42	N	31	F	UROGENITAL OTHER		
424	F	32	N	31	F	UROGENITAL OTHER		
425	F	33	N	24	F	UROGENITAL OTHER		
426	F	31	U	27	M	UROGENITAL OTHER		
427	F	31	U	29	M	UROGENITAL OTHER		
428	F	36	N	30	F	UROGENITAL OTHER		
429	F	36	N	26	F	UROGENITAL OTHER		
430	F	43	N	24	F	UROGENITAL OTHER		
431	F	42	U	34	F	UROGENITAL OTHER		
432	F	32	N	24	M	UROGENITAL OTHER	MUSCULOSK. OTHER	
433	F	31	N	22	M	UROGENITAL OTHER		
434	F	51	N	23	M	UROGENITAL OTHER		
435	F	31	N	23	M	UROGENITAL OTHER		
436	F	30	N	23	M	UROGENITAL OTHER		
437	F	29	N	27	M	UROGENITAL OTHER	BIRTHMARK	
438	F	50	N	23	F	UROGENITAL OTHER		
439	F	39	N	23	F	UROGENITAL OTHER		
440	F	32	N	24	F	UROGENITAL OTHER		
441	F	34	U	26	M	UROGENITAL OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
442	F	46	N	24	F	VENTRICULAR SEPT		
443	F	40	N	35	M	VENTRICULAR SEPT	UROGENITAL OTHER	MUSCULOSK. OTHER
444	F	32	N	29	F	VENTRICULAR SEPT		
445	F	29	U	25	F	VENTRICULAR SEPT		
446	F	43	N	23	F	VENTRICULAR SEPT		
447	F	41	N	33	M	VENTRICULAR SEPT	LIMB AMPUTATION	
448	F	40	N	23	F	VENTRICULAR SEPT		
449	F	32	N	26	M	VENTRICULAR SEPT		
450	F	37	N	32	F	VENTRICULAR SEPT		
451	M	61	U	24	F			MUSCULOSK. OTHER
452	M	42	U	33	F	ANENCEPHALY		
453	M	29	U	27	F	ARTRIAL SEPTAL		
454	M	39	U	25	F	ARTRIAL SEPTAL		
455	M	65	U	31	F	ARTRIAL SEPTAL		
456	M	41	U	30	F	ARTRIAL SEPTAL	CAVERNOUS HEMANG	
457	M	37	U	29	F	ARTRIAL SEPTAL		
458	M	38	U	28	F	ARTRIAL SEPTAL		
459	M	46	U	25	F	ARTRIAL SEPTAL		
460	M	36	N	23	M	ARTRIAL SEPTAL		
461	M	66	U	25	F	ARTRIAL SEPTAL		
462	M	51	U	23	F	BIRTHMARK		
463	M	76	U	20	M	BIRTHMARK		
464	M	28	U	21	F	BIRTHMARK		
465	M	39	N	32	F	BIRTHMARK		
466	M	42	U	27	F	BIRTHMARK		
467	M	43	U	41	F	BIRTHMARK	MUSCULOSK. OTHER	
468	M	43	U	25	F	BIRTHMARK		
469	M	43	U	24	F	BIRTHMARK	NEVUS	GASTRO INT.OTHER
470	M	22	U	20	F	BIRTHMARK		
471	M	52	U	28	F	BIRTHMARK		
472	M	54	U	37	F	BIRTHMARK		
473	M	32	U	30	M	BIRTHMARK		
474	M	40	U	34	M	BIRTHMARK		
475	M	61	U	28	F	BIRTHMARK		
476	M	53	U	36	M	BIRTHMARK		
477	M	30	U	25	M	BIRTHMARK		
478	M	56	U	24	F	BIRTHMARK		
479	M	56	U	29	F	BIRTHMARK		
480	M	56	U	31	M	BIRTHMARK		
481	M	56	U	32	F	BIRTHMARK		
482	M	38	N	25	F	BIRTHMARK		
483	M	50	U	26	F	BIRTHMARK		
484	M	42	U	31	F	BIRTHMARK		
485	M	55	U	27	F	BIRTHMARK*		
486	M	42	U	31	F	BIRTHMARK		
487	M	48	U	25	F	BIRTHMARK		
488	M	33	U	30	F	BIRTHMARK		
489	M	56	U	31	M	BIRTHMARK		
490	M	56	U	36	F	BIRTHMARK		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
491	M	36	U	28	M	BIRTHMARK		
492	M	36	U	28	F	BIRTHMARK		
493	M	30	U	30	F	BIRTHMARK		
494	M	35	U	25	M	BIRTHMARK		
495	M	38	U	25	M	CARDIOV. OTHER		
496	M	49	U	29	F	CARDIOV. OTHER		
497	M	61	U	37	F	CARDIOV. OTHER		
498	M	56	U	28	M	CARDIOV. OTHER		
499	M	49	U	30	M	CARDIOV. OTHER		
500	M	61	U	30	M	CARDIOV. OTHER		
501	M	42	U	24	M	CARDIOV. OTHER		
502	M	34	U	33	M	CARDIOV. OTHER	CNTL.NERV. OTHER	
503	M	43	U	34	F	CARDIOV. OTHER		
504	M	52	U	32	F	CARDIOV. OTHER		
505	M	42	U	38	M	CARDIOV. OTHER		
506	M	58	U	30	M	CARDIOV. OTHER	CLEFT PALATE/LIP	
507	M	56	U	28	M	CARDIOV. OTHER		
508	M	41	U	32	F	CARDIOV. OTHER		
509	M	52	U		F	CARDIOV. OTHER		
510	M	41	U	31	F	CAVERNOUS HEMANG		
511	M	31	U	28	M	CAVERNOUS HEMANG		
512	M	46	U	26	F	CAVERNOUS HEMANG		
513	M	51	U	34	F	CAVERNOUS HEMANG	MUSCULOSK. OTHER	
514	M	53	U	32	F	CAVERNOUS HEMANG		
515	M	53	U	35	F	CAVERNOUS HEMANG		
516	M	48	U	30	M	CAVERNOUS HEMANG		
517	M	50	U	28	F	CAVERNOUS HEMANG		
518	M	58	U	33	M	CAVERNOUS HEMANG		
519	M	61	U	28	F	CAVERNOUS HEMANG		
520	M	67	U	29	F	CAVERNOUS HEMANG		
521	M	55	U	31	M	CLEFT PALATE/LIP	UROGENITAL OTHER	
522	M	43	U	32	M	CLEFT PALATE/LIP		
523	M	39	U	26	M	CLEFT PALATE/LIP		
524	M	52	N	26	M	CLEFT PALATE/LIP		
525	M	48	U	28	F	CLEFT PALATE/LIP		
526	M	51	U	32	M	CNTL.NERV. OTHER		
527	M	43	U	29	F	CNTL.NERV. OTHER		
528	M	61	U	35	M	CNTL.NERV. OTHER		
529	M	50	U	28	F	CNTL.NERV. OTHER	MUSCULOSK. OTHER	
530	M	46	N	28	F	CNTL.NERV. OTHER		
531	M	46	N	28	F	CNTL.NERV. OTHER		
532	M	45	U	27	M	CNTL.NERV. OTHER	MUSCULOSK. OTHER	
533	M	53	U	29	F	CNTL.NERV. OTHER		
534	M	39	U	25	F	CNTL.NERV. OTHER		
535	M	39	U	29	F	CNTL.NERV. OTHER		
536	M	50	U	34	M	CNTL.NERV. OTHER	SYNDACTYLY	MUSCULOSK. OTHER
537	M	56	U	35	M	CNTL.NERV. OTHER		
538	M	68	U	27	M	CNTL.NERV. OTHER		
539	M	44	U	25	M	CNTL.NERV. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT INTVIEW	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
540	M	46	U	31	F	CNTL.NERV. OTHER		
541	M	48	U	34	M	CNTL.NERV. OTHER		
542	M	46	U	32	M	CNTL.NERV. OTHER		
543	M	52	U	31	F	CNTL.NERV. OTHER		
544	M	30	U	27	M	CNTL.NERV. OTHER	MUSCULOSK. OTHER	
545	M	52	U	39	M	CNTL.NERV. OTHER		
546	M	55	U	29	M	CNTL.NERV. OTHER		
547	M	53	U	35	F	CNTL.NERV. OTHER		
548	M	53	U	29	F	CNTL.NERV. OTHER		
549	M	31	U	25	M	CNTL.NERV. OTHER	UNDESC. TESTICLE	
550	M	64	U	32	M	CNTL.NERV. OTHER		
551	M	50	U	27	M	CNTL.NERV. OTHER		
552	M	40	U	26	F	CNTL.NERV. OTHER		
553	M	48	U	31	M	CNTL.NERV. OTHER		
554	M	52	U	36	M	CNTL.NERV. OTHER		
555	M	65	U	32	F	CNTL.NERV. OTHER		
556	M	52	U	29	M	GASTRO INT.OTHER		
557	M	31	U	30	M	GASTRO INT.OTHER		
558	M	40	U	32	M	GASTRO INT.OTHER		
559	M	47	U	28	M	GASTRO INT.OTHER		
560	M	63	U	31	M	GASTRO INT.OTHER		
561	M	63	U	41	M	GASTRO INT.OTHER		
562	M	43	U	23	F	GASTRO INT.OTHER	CNTL.NERV. OTHER	
563	M	51	U	32	M	GASTRO INT.OTHER		
564	M	37	U	37	F	GASTRO INT.OTHER		
565	M	61	U	25	M	GASTRO INT.OTHER	HYPOSPADIAS	
566	M	41	U	36	F	GASTRO INT.OTHER		
567	M	61	U	33	M	GASTRO INT.OTHER	CNTL.NERV. OTHER	
568	M	41	U	24	M	GASTRO INT.OTHER		
569	M	50	U	27	M	HYPOSPADIAS	UNDESC. TESTICLE	
570	M	55	U	37	M	HYPOSPADIAS		
571	M	42	U	29	M	HYPOSPADIAS	CAVERNOUS HEMANG	
572	M	29	U	29		HYPOSPADIAS		
573	M	34	U	31	M	HYPOSPADIAS		
574	M	56	U	25	M	HYPOSPADIAS		
575	M	59	U	27	M	HYPOSPADIAS		
576	M	56	U	29	M	HYPOSPADIAS		
577	M	33	U	26	M	HYPOSPADIAS		
578	M	61	U	27	M	HYPOSPADIAS		
579	M	50	U	31	F	LIMB AMPUTATION	IMPERFORATE ANUS	
580	M	45	U	26	M	MUSCULOSK. OTHER		
581	M	45	U	30	F	MUSCULOSK. OTHER		
582	M	61	U	25	F	MUSCULOSK. OTHER		
583	M	50	U	27	F	MUSCULOSK. OTHER		
584	M	47	U	26	F	MUSCULOSK. OTHER		
585	M	41	U	30	M	MUSCULOSK. OTHER		
586	M	25	U	21	F	MUSCULOSK. OTHER		
587	M	50	U	29	M	MUSCULOSK. OTHER		
588	M	50	U	30	M	MUSCULOSK. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
589	M	45	U	27	M	MUSCULOSK. OTHER	CNTL.NERV. OTHER	
590	M	45	U	37	M	MUSCULOSK. OTHER		
591	M	54	U	23	F	MUSCULOSK. OTHER		
592	M	40	U	31	F	MUSCULOSK. OTHER		
593	M	36	U	29	M	MUSCULOSK. OTHER		
594	M	38	U	29	M	MUSCULOSK. OTHER		
595	M	28	U	21	M	MUSCULOSK. OTHER		
596	M	34	U	24	F	MUSCULOSK. OTHER		
597	M	53	U	27	F	MUSCULOSK. OTHER	RESPIRAT. OTHER	
598	M	48	U	33	F	MUSCULOSK. OTHER		
599	M	37	U	26	M	MUSCULOSK. OTHER		
600	M	54	U	28	F	MUSCULOSK. OTHER		
601	M	51	U	35	F	MUSCULOSK. OTHER		
602	M	51	U	23	F	MUSCULOSK. OTHER		
603	M	60	U	30	F	MUSCULOSK. OTHER	SKIN. OTHER	
604	M	40	U	30	M	MUSCULOSK. OTHER		
605	M	40	U	38	M	MUSCULOSK. OTHER	CAVERNOUS HEMANG	
606	M	53	U	36	M	MUSCULOSK. OTHER	CNTL.NERV. OTHER	UROGENITAL OTHER
607	M	35	U	27	F	MUSCULOSK. OTHER		
608	M	54	U	34	F	MUSCULOSK. OTHER		
609	M	33	U	27	F	MUSCULOSK. OTHER		
610	M	62	U	30	F	MUSCULOSK. OTHER		
611	M	35	U	24	M	MUSCULOSK. OTHER		
612	M	52	U	25	M	MUSCULOSK. OTHER		
613	M	35	U	23	F	MUSCULOSK. OTHER		
614	M	45	U	29	M	MUSCULOSK. OTHER		
615	M	45	U	31	F	MUSCULOSK. OTHER		
616	M	44	U	23	F	MUSCULOSK. OTHER		
617	M	46	U	33	M	MUSCULOSK. OTHER		
618	M	47	U	28	M	NEVUS		
619	M	30	U	27	F	NEVUS		
620	M	52	U	30	M	NEVUS		
621	M	33	U	25	F	NEVUS		
622	M	55	U	33	F	NEVUS		
623	M	39	U	28	F	NEVUS		
624	M	42	U	31	F	NEVUS		
625	M	43	U	28	F	NEVUS		
626	M	28	U	24	F	NEVUS		
627	M	42	U	25	M	NEVUS		
628	M	56	U		F	NEVUS		
629	M	26	U	24	F	NEVUS		
630	M	39	U	31	F	PATENT DUCTUS	RESPIRAT. OTHER	
631	M	39	U	31	F	PATENT DUCTUS	RESPIRAT. OTHER	
632	M	47	U	28	F	PATENT DUCTUS		
633	M	40	U	29	F	PATENT DUCTUS		
634	M	35	U	32	M	PATENT DUCTUS		
635	M	41	U	30	M	PATENT DUCTUS		
636	M	50	U	28	M	RESPIRAT. OTHER		
637	M	54	U	30	M	RESPIRAT. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPON-DENT	RESPON-DENT AGE AT QUES ADM	RESPON-DENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
638	M	54	U	33	M	RESPIRAT. OTHER	BIRTHMARK	
639	M	48	U	26	F	RESPIRAT. OTHER	MUSCULOSK. OTHER	
640	M	36	U	33	F	RESPIRAT. OTHER		
641	M	37	U	25	F	RESPIRAT. OTHER		
642	M	37	U	29	F	RESPIRAT. OTHER		
643	M	37	U	31	M	RESPIRAT. OTHER		
644	M	48	U	34	M	RESPIRAT. OTHER		
645	M	50	U		M	RESPIRAT. OTHER		
646	M	35	U	31	M	RESPIRAT. OTHER		
647	M	41	U	19	F	SKIN, OTHER		
648	M	41	U	21	M	SKIN, OTHER		
649	M	48	N	24	M	SKIN, OTHER		
650	M	48	N	28	M	SKIN, OTHER		
651	M	48	N	30	F	SKIN, OTHER		
652	M	38	U	29	M	SKIN, OTHER		
653	M	32	U	26	F	SKIN, OTHER	BIRTHMARK	
654	M	51	U	29	F	SKIN, OTHER		
655	M	43	U	29	F	SKIN, OTHER		
656	M	32	N	28	M	SKIN, OTHER		
657	M	32	U	29	F	SKIN, OTHER		
658	M	32	U	32	F	SKIN, OTHER		
659	M	40	U	23	M	SKIN, OTHER		
660	M	38	U	27	M	SKIN, OTHER		
661	M	14	U	31	M	SKIN, OTHER		
662	M	39	U	28	F	SKIN, OTHER		
663	M	39	U	30	F	SKIN, OTHER		
664	M	30	U	34	M	SKIN, OTHER		
665	M	39	U	26	F	SKIN, OTHER		
666	M	30	U	26	M	SKIN, OTHER		
667	M	35	U	28	M	SKIN, OTHER		
668	M	38	U	34	F	SKIN, OTHER		
669	M	44	U	30	M	SKIN, OTHER		
670	M	68	U	35	F	SKIN, OTHER		
671	M	61	U	29	F	SKIN, OTHER		
672	M	35	U	26	F	SKIN, OTHER		
673	M	61	U	32	F	SKIN, OTHER		
674	M	61	U	29	M	SPINA BIFIDA		
675	M	64	U	30	M	SPINA BIFIDA		
676	M	61	U	33	M	SPINA BIFIDA		
677	M	40	U	29	M	SYNDACTYLY		
678	M	33	U	26	M	SYNDACTYLY		
679	M	32	U	29	M	SYNDACTYLY		
680	M	33	U	28	F	SYNDACTYLY		
681	M	41	U	25	M	UNDESC. TESTICLE		
682	M	60	U	35	M	UNDESC. TESTICLE	MUSCULOSK. OTHER	
683	M	51	U	25	M	UNDESC. TESTICLE		
684	M	30	U	19	M	UNDESC. TESTICLE		
685	M	34	U	36	M	UNDESC. TESTICLE		
686	M	43	U	20	M	UNDESC. TESTICLE		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE EXPOSED RESPONDENTS

LIST	SEX OF RESPON-DENT	RESPON-DENT AGE AT QUES ADM	RESPON-DENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
687	M	43	U	28	M	UNDESC. TESTICLE		
688	M	52	U	34	F	UNDESC. TESTICLE		
689	M	44	U	25	M	UNDESC. TESTICLE		
690	M	67	U	28	M	UNDESC. TESTICLE		
691	M	31	U	28	M	UROGENITAL OTHER		
692	M	60	U	29	F	UROGENITAL OTHER	GASTRO INT.OTHER	
693	M	54	U	29	F	UROGENITAL OTHER		
694	M	50	U	25	F	UROGENITAL OTHER	MUSCULOSK. OTHER	
695	M	38	U	26	M	UROGENITAL OTHER		
696	M	36	U	32	F	UROGENITAL OTHER		
697	M	53	U	36	F	UROGENITAL OTHER		
698	M	41	U	29	M	UROGENITAL OTHER		
699	M	50	U	27	F	UROGENITAL OTHER		
700	M	33	U	29	F	UROGENITAL OTHER		
701	M	56	U		M	UROGENITAL OTHER		
702	M	47	U	33	F	UROGENITAL OTHER		
703	M	37	U	28	F	VENTRICULAR SEPT		
704	M	32	U	29	M	VENTRICULAR SEPT		
705	M	32	U	32	M	VENTRICULAR SEPT	CARDIOV. OTHER	CLEFT PALATE/LIP
706	M	32	U	24	F	VENTRICULAR SEPT		
707	M	33	U	30	F	VENTRICULAR SEPT	SKIN. OTHER	
708	M	62	U	26	F	VENTRICULAR SEPT		
709	M	56	U	29	M	VENTRICULAR SEPT		
710	M	34	U	26	M	VENTRICULAR SEPT	CARDIOV. OTHER	
711	M	47	U	29	M	VENTRICULAR SEPT		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE NON-EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
1		29	N	25	F	BIRTHMARK		
2		29	N	28	M	BIRTHMARK	MUSCULOSK. OTHER	
3	F	41	N	27	M	ANENCEPHALY		
4	F	51	O	26	M	ARTRIAL SEPTAL		
5	F	41	N	21	M	ARTRIAL SEPTAL	RESPIRAT. OTHER	
6	F	29	N	18	M	ARTRIAL SEPTAL		
7	F	34	N	19	F	BIRTHMARK		
8	F	34	N	21	F	BIRTHMARK		
9	F	34	N	23	F	BIRTHMARK		
10	F	45	N	25	F	BIRTHMARK		
11	F	27	N	17	F	BIRTHMARK		
12	F	32	O	29	M	BIRTHMARK		
13	F	31	N	29	M	BIRTHMARK		
14	F	28	N	27	F	BIRTHMARK		
15	F	31	N	29	F	BIRTHMARK		
16	F	36	N	30	F	BIRTHMARK		
17	F	33	O	21	M	BIRTHMARK		
18	F	30	N	27	M	BIRTHMARK		
19	F	55	O	19	M	BIRTHMARK		
20	F	55	O	21	M	BIRTHMARK		
21	F	55	O	22	M	BIRTHMARK		
22	F	55	O	25	M	BIRTHMARK		
23	F	55	O	28	M	BIRTHMARK		
24	F	55	O	29	M	BIRTHMARK		
25	F	55	O	30	F	BIRTHMARK		
26	F	55	O	32	M	BIRTHMARK		
27	F	55	O	33	F	BIRTHMARK		
28	F	46	O	28	F	BIRTHMARK		
29	F	39	O	25	M	CARDIOV. OTHER		
30	F	28	N	26	M	CARDIOV. OTHER	BIRTHMARK	
31	F	31	O	27	F	CARDIOV. OTHER		
32	F	32	N	31	M	CARDIOV. OTHER		
33	F	31	N	25	M	CARDIOV. OTHER		
34	F	45	O	29	M	CARDIOV. OTHER		
35	F	35	N	25	F	CARDIOV. OTHER		
36	F	54	O	21	F	CARDIOV. OTHER		
37	F	60	O	21	F	CARDIOV. OTHER		
38	F	29	N	22	M	CARDIOV. OTHER		
39	F	38	N	26	M	CARDIOV. OTHER		
40	F	38	N	29	M	CARDIOV. OTHER		
41	F	46	N	23	M	CARDIOV. OTHER		
42	F	40	O	26	M	CARDIOV. OTHER		
43	F	36	O	26	F	CARDIOV. OTHER		
44	F	51	O	30	M	CARDIOV. OTHER		
45	F	44	N	27	M	CAVERNOUS HEMANG		
46	F	33	N	28	M	CAVERNOUS HEMANG		
47	F	42	O	24	F	CAVERNOUS HEMANG		
48	F	27	N	26	F	CLEFT PALATE/LIP		
49	F	46	O	27	M	CNTL.NERV. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE NON-EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT DOLS ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
50	F	64	O	36	F	CNTL.NERV. OTHER		
51	F	55	O	24	F	CNTL.NERV. OTHER		
52	F	48	N	31	F	CNTL.NERV. OTHER		
53	F	48	N	33	M	CNTL.NERV. OTHER		
54	F	31	O	26	M	CNTL.NERV. OTHER	CARDIOV. OTHER	
55	F	45	N	24	F	CNTL.NERV. OTHER		
56	F	41	O	17	F	CNTL.NERV. OTHER		
57	F	41	O	17	F	CNTL.NERV. OTHER		
58	F	33	O	25	M	CNTL.NERV. OTHER		
59	F	28	N	27	F	CNTL.NERV. OTHER		
60	F	30	O	27	F	CNTL.NERV. OTHER		
61	F	26	O	25	F	CNTL.NERV. OTHER		
62	F	37	O	26	M	GASTRO INT.OTHER		
63	F	31	N	24	F	GASTRO INT.OTHER		
64	F	38	O	23	M	GASTRO INT.OTHER		
65	F	44	N	32	M	GASTRO INT.OTHER		
66	F	46	O	23	M	GASTRO INT.OTHER		
67	F	35	N	27	F	GASTRO INT.OTHER		
68	F	26	N	24	M	GASTRO INT.OTHER		
69	F	29	O	20	F	GASTRO INT.OTHER		
70	F	29	O	23	M	GASTRO INT.OTHER		
71	F	29	O	24	F	GASTRO INT.OTHER		
72	F	47	O	26	M	HYPOSPADIAS		
73	F	24	N	19	M	HYPOSPADIAS		
74	F	33	N	26	M	HYPOSPADIAS		
75	F	36	O	25	M	MUSCULOSK. OTHER		
76	F	37	N	24	F	MUSCULOSK. OTHER		
77	F	24	O	21	F	MUSCULOSK. OTHER		
78	F	38	N	26	F	MUSCULOSK. OTHER		
79	F	39	N	22	F	MUSCULOSK. OTHER		
80	F	39	N	25	M	MUSCULOSK. OTHER		
81	F	39	O	26	F	MUSCULOSK. OTHER		
82	F	48	N	27	F	MUSCULOSK. OTHER		
83	F	46	N	31	F	MUSCULOSK. OTHER		
84	F	31	N	21	F	MUSCULOSK. OTHER		
85	F	37	N	30	M	MUSCULOSK. OTHER		
86	F	50	N	21	M	MUSCULOSK. OTHER		
87	F	50	N	24	M	MUSCULOSK. OTHER		
88	F	35	N	25	F	MUSCULOSK. OTHER		
89	F	44	N	29	M	MUSCULOSK. OTHER		
90	F	38	O	23	M	MUSCULOSK. OTHER		
91	F	48	O	30	F	MUSCULOSK. OTHER		
92	F	40	O	27	M	MUSCULOSK. OTHER		
93	F	38	N	19	M	NEVUS		
94	F	50	N	29	F	NEVUS		
95	F	43	O	38	F	PATENT DUCTUS		
96	F	30	O	25	M	PATENT DUCTUS		
97	F	48	N	31	M	PATENT DUCTUS		
98	F	50	O	27	M	RESPIRAT. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE NON-EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT QCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
99	F	34	N	25	M	RESPIRAT. OTHER	BIRTHMARK	
100	F	43	N	22	M	RESPIRAT. OTHER		
101	F	27	0	23	M	RESPIRAT. OTHER	RESPIRAT. OTHER	
102	F	28	N	25	M	RESPIRAT. OTHER		
103	F	28	N	21	M	RESPIRAT. OTHER		
104	F	36	N	20	F	RESPIRAT. OTHER		
105	F	52	N	23	F	SKIN, OTHER		
106	F	27	N	25	F	SKIN, OTHER		
107	F	31	N	25	F	SKIN, OTHER		
108	F	35	N	25	F	SKIN, OTHER		
109	F	31	N	25	M	SKIN, OTHER		
110	F	29	N	27	M	SKIN, OTHER	CNTL.NERV. OTHER	
111	F	50	N	25	F	SKIN, OTHER	CNTL.NERV. OTHER	
112	F	29	N	20	M	SKIN, OTHER		
113	F	38	N	32	M	SKIN, OTHER		
114	F	39	0	24	F	SPINA BIFIDA		
115	F	41	0	18	M	SPINA BIFIDA		
116	F	41	0	21	M	SPINA BIFIDA		
117	F	47	0	29	M	SPINA BIFIDA		
118	F	33	0	27	F	SPINA BIFIDA		
119	F	35	0	22	M	SPINA BIFIDA		
120	F	33	N	18	M	SPINA BIFIDA	HYDROCEPHALUS	CNTL.NERV. OTHER
121	F	37	0	33	M	SYNDACTYLY		
122	F	36	N	25	M	UNDESC. TESTICLE		
123	F	50	N	22	M	UNDESC. TESTICLE		
124	F	40	0	35	M	UNDESC. TESTICLE		
125	F	28	N	23	M	UROGENITAL OTHER		
126	F	40	N	23	F	UROGENITAL OTHER	CNTL.NERV. OTHER	
127	F	37	N	23	M	UROGENITAL OTHER	MUSCULOSK. OTHER	
128	F	44	0	22	F	UROGENITAL OTHER		
129	F	35	N	22	F	VENTRICULAR SEPT		
130	F	35	N	25	M	VENTRICULAR SEPT		
131	M	58	0	25	F	ANENCEPHALY		
132	M	46	0	23	M	BIRTHMARK		
133	M	36	0	29	M	BIRTHMARK		
134	M	46	0	31	M	BIRTHMARK		
135	M	38	0	23	M	BIRTHMARK		
136	M	38	0	28	M	BIRTHMARK		
137	M	63	0	28	M	BIRTHMARK		
138	M	35	0	28	F	BIRTHMARK		
139	M	41	0	34	M	BIRTHMARK		
140	M	64	0	33	M	BIRTHMARK		
141	M	39	0	36	F	CARDIOV. OTHER		
142	M	41	0	23	M	CARDIOV. OTHER	MUSCULOSK. OTHER	
143	M	42	0	31	F	CARDIOV. OTHER		
144	M	42	N	29	M	CARDIOV. OTHER	RESPIRAT. OTHER	
145	M	33	0	29	F	CARDIOV. OTHER		
146	M	31	0	30	M	CARDIOV. OTHER		
147	M	46	0	21	F	CARDIOV. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE NON-EXPOSED RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
148	M	51	D	33	F	CARDIOV. OTHER		
149	M	31	D	30	M	CAVERNOUS HEMANG		
150	M	53	D	35	M	CAVERNOUS HEMANG		
151	M	31	D	27	F	CAVERNOUS HEMANG		
152	M	37	D	35	M	CAVERNOUS HEMANG		
153	M	55	D	35	M	CLEFT PALATE/LIP		
154	M	37	D	28	M	CNTL.NERV. OTHER		
155	M	56	D	38	F	CNTL.NERV. OTHER		
156	M	56	D	32	M	CNTL.NERV. OTHER		
157	M	49	D	30	M	CNTL.NERV. OTHER		
158	M	49	D	31	M	CNTL.NERV. OTHER		
159	M	62	D	26	F	CNTL.NERV. OTHER		
160	M	40	D	23	F	CNTL.NERV. OTHER		
161	M	39	D	31	M	CNTL.NERV. OTHER		
162	M	47	D	24	F	CNTL.NERV. OTHER		
163	M	43	N	35	F	CNTL.NERV. OTHER		
164	M	55	D	35	F	CNTL.NERV. OTHER	MUSCULOSK. OTHER	
165	M	44	D	25	M	GASTRO INT.OTHER		
166	M	55	D	36	M	MUSCULOSK. OTHER		
167	M	55	D	39	M	MUSCULOSK. OTHER		
168	M	38	D	30	M	MUSCULOSK. OTHER		
169	M	39	D	27	F	MUSCULOSK. OTHER		
170	M	49	D	31	M	MUSCULOSK. OTHER		
171	M	38	D	20	F	MUSCULOSK. OTHER		
172	M	72	D	25	M	PATENT DUCTUS		
173	M	33	D	29	M	RESPIRAT. OTHER		
174	M	63	D	24	M	SKIN, OTHER		
175	M	34	D	30	M	SKIN, OTHER		
176	M	61	D	43	F	SPINA BIFIDA		
177	M	65	D	42	F	SYNDACTYLY		
178	M	56	D	24	M	UNDESC. TESTICLE		
179	M	62	D	23	M	UNDESC. TESTICLE		
180	M	62	D	32	M	UROGENITAL OTHER		
181	M	56	D	29		VENTRICULAR SEPT		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE RANDOM SAMPLE RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
1	F	35	N	30	F	BIRTHMARK		
2	F	41	N	23	F	BIRTHMARK		
3	F	34	N	26	F	BIRTHMARK		
4	F	49	N	28	M	BIRTHMARK		
5	F	41	N	29	M	BIRTHMARK		
6	F	35	N	24	M	BIRTHMARK		
7	F	35	N	32	M	BIRTHMARK		
8	F	34	N	30	F	BIRTHMARK		
9	F	32	N	23	F	BIRTHMARK		
10	F	29	N	27	M	BIRTHMARK		
11	F	41	N	24	M	BIRTHMARK		
12	F	41	N	26	F	BIRTHMARK		
13	F	34	N	25	F	BIRTHMARK		
14	F	29	N	28	M	BIRTHMARK		
15	F	40	N	25	M	BIRTHMARK		
16	F	34	N	25	M	BIRTHMARK		
17	F	44	N	36	M	CARDIOV. OTHER		
18	F	36	N	25	M	CAVERNOUS HEMANG		
19	F	36	N	28	F	CAVERNOUS HEMANG		
20	F	40	N	24	F	CAVERNOUS HEMANG		
21	F	34	N	28	M	CAVERNOUS HEMANG		
22	F	50	N	33	M	CNTL.NERV. OTHER		
23	F	32	N	24	F	CNTL.NERV. OTHER		
24	F	40	N	20	M	CNTL.NERV. OTHER		
25	F	53	N	33	F	CNTL.NERV. OTHER		
26	F	53	N	34	M	CNTL.NERV. OTHER		
27	F	37	N	28	F	CNTL.NERV. OTHER		
28	F	34	N	21	M	GASTRO INT.OTHER	UNDESC. TESTICLE	
29	F	35	N	23	M	GASTRO INT.OTHER		
30	F	44	N	26	M	GASTRO INT.OTHER		
31	F	40	N	23	M	GASTRO INT.OTHER		
32	F	42	N	25	M	HYPOSPADIAS		
33	F	31	N	24	M	HYPOSPADIAS		
34	F	40	N	27	M	HYPOSPADIAS		
35	F	36	N	20	M	HYPOSPADIAS	UNDESC. TESTICLE	MUSCULOSK. OTHER
36	F	42	N	26	F	MUSCULOSK. OTHER		
37	F	34	N	25	F	MUSCULOSK. OTHER		
38	F	34	N	28	M	MUSCULOSK. OTHER		
39	F	40	U	34	F	MUSCULOSK. OTHER		
40	F	42	N	30	F	MUSCULOSK. OTHER		
41	F	36	N	23	M	MUSCULOSK. OTHER		
42	F	36	N	25	F	MUSCULOSK. OTHER		
43	F	42	N	34	F	MUSCULOSK. OTHER	UROGENITAL OTHER	
44	F	43	N	32	M	MUSCULOSK. OTHER		
45	F	32	N	25	F	MUSCULOSK. OTHER		
46	F	32	N	28	M	MUSCULOSK. OTHER		
47	F	31	N	28	M	MUSCULOSK. OTHER	UROGENITAL OTHER	
48	F	31	N	27	F	MUSCULOSK. OTHER		
49	F	40	N	26	M	MUSCULOSK. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE RANDOM SAMPLE RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT DOES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
50	F	50	N	35	F	MUSCULOSK. OTHER		
51	F	38	O	34	M	NEVUS		
52	F	39	N	26	M	NEVUS		
53	F	54	O	32	F	NEVUS		
54	F	39	N	25	M	NEVUS		
55	F	32	N	21	F	NEVUS		
56	F	33	N	30	M	NEVUS		
57	F	37	N	19	M	NEVUS	CARDIOV. OTHER	
58	F	47	N	29	M	NEVUS		
59	F	36	N	30	M	RESPIRAT. OTHER		
60	F	39	N	28	M	RESPIRAT. OTHER	GASTRO INT.OTHER	
61	F	34	N	23	F	RESPIRAT. OTHER		
62	F	27	N	27	F	RESPIRAT. OTHER		
63	F	39	N	25	M	RESPIRAT. OTHER	SKIN, OTHER	
64	F	39	N	31	M	RESPIRAT. OTHER		
65	F	27	N	26	M	RESPIRAT. OTHER	UROGENITAL OTHER	
66	F	31	N	28	M	RESPIRAT. OTHER		
67	F	34	N	23	F	SKIN, OTHER		
68	F	42	N	23	M	SKIN, OTHER		
69	F	37	N	20	M	SKIN, OTHER		
70	F	37	N	25	F	SKIN, OTHER		
71	F	27	N	23	M	SKIN, OTHER		
72	F	49	N	22	M	SKIN, OTHER		
73	F	40	O	32	F	SKIN, OTHER		
74	F	49	N	26	F	SPINA BIFIDA	HYDROCEPHALUS	
75	F	38	N	32	M	UNDESC. TESTICLE		
76	F	37	N	25	M	UNDESC. TESTICLE		
77	F	40	N	26	M	UNDESC. TESTICLE	MUSCULOSK. OTHER	
78	F	26	N	23	M	UNDESC. TESTICLE		
79	F	40	N	28	M	UNDESC. TESTICLE	BIRTHMARK	
80	F	41	N	25	M	UNDESC. TESTICLE		
81	F	38	N	23	M	UNDESC. TESTICLE		
82	F	33	N	23	M	UNDESC. TESTICLE		
83	F	32	N	26	M	VENTRICULAR SEPT		
84	M	42	O	33	F	ANENCEPHALY		
85	M	65	O	31	F	ARTRIAL SEPTAL		
86	M	22	O	20	F	BIRTHMARK		
87	M	54	O	37	F	BIRTHMARK		
88	M	52	O	30	M	BIRTHMARK		
89	M	53	O	36	M	BIRTHMARK		
90	M	38	O	24	F	BIRTHMARK		
91	M	38	O	29	F	BIRTHMARK		
92	M	58	O	31	M	BIRTHMARK		
93	M	58	O	32	F	BIRTHMARK		
94	M	55	O	27	F	BIRTHMARK		
95	M	58	O	31	M	BIRTHMARK		
96	M	58	O	18	F	BIRTHMARK		
97	M	61	O	37	F	CARDIOV. OTHER		
98	M	58	O	28	M	CARDIOV. OTHER		

REPORTED REPRODUCTIVE OUTCOME - CONGENITAL ABNORMALITY AMONG THE CHILDREN OF THE RANDOM SAMPLE RESPONDENTS

LIST	SEX OF RESPONDENT	RESPONDENT AGE AT QUES ADM	RESPONDENT OCCN	MOTHER AGE AT PREG	SEX OF CHILD	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY	CONGENITAL ABNORMALITY
99	M	42	U	38	M	CARDIOV. OTHER		
100	M	53	U	32	F	CAVERNOUS HEMANG		
101	M	53	U	35	F	CAVERNOUS HEMANG		
102	M	50	U	28	F	CAVERNOUS HEMANG		
103	M	61	U	35	M	CNTL.NERV. OTHER		
104	M	55	U	29	M	CNTL.NERV. OTHER		
105	M	53	U	35	F	CNTL.NERV. OTHER		
106	M	31	U	30	M	GASTRO INT.OTHER		
107	M	46	U	32	M	GASTRO INT.OTHER		
108	M	47	U	28	M	GASTRO INT.OTHER		
109	M	63	U	31	M	GASTRO INT.OTHER		
110	M	63	U	41	M	GASTRO INT.OTHER		
111	M	56	U	27	M	HYPOSPADIAS	UNDESC. TESTICLE	
112	M	55	U	37	M	HYPOSPADIAS		
113	M	33	U	26	M	HYPOSPADIAS		
114	M	45	U	26	M	MUSCULOSK. OTHER		
115	M	45	U	30	F	MUSCULOSK. OTHER		
116	M	61	U	25	F	MUSCULOSK. OTHER		
117	M	50	U	27	F	MUSCULOSK. OTHER		
118	M	25	U	21	F	MUSCULOSK. OTHER		
119	M	54	U	28	F	MUSCULOSK. OTHER		
120	M	35	U	27	F	MUSCULOSK. OTHER		
121	M	59	U	34	F	MUSCULOSK. OTHER		
122	M	62	U	30	F	MUSCULOSK. OTHER		
123	M	52	U	25	M	MUSCULOSK. OTHER		
124	M	33	U	25	F	NEVUS		
125	M	55	U	33	F	NEVUS		
126	M	42	U	31	F	NEVUS		
127	M	40	U	29	F	PATENT DUCTUS		
128	M	41	U	30	M	PATENT DUCTUS		
129	M	54	U	30	M	RESPIRAT. OTHER		
130	M	54	U	33	M	RESPIRAT. OTHER	BIRTHMARK	
131	M	56	U	33	F	RESPIRAT. OTHER		
132	M	30	U		M	RESPIRAT. OTHER		
133	M	32	N	28	M	SKIN. OTHER		
134	M	38	U	27	M	SKIN. OTHER		
135	M	61	U	29	M	SPINA BIFIDA		
136	M	69	U	30	M	SPINA BIFIDA		
137	M	33	U	28	F	SYNDACTYLY		
138	M	52	U	34	F	UNDESC. TESTICLE		
139	M	44	U	25	M	UNDESC. TESTICLE		
140	M	53	U	36	F	UROGENITAL OTHER		
141	M	50	U	27	F	UROGENITAL OTHER		
142	M	47	U	33	F	UROGENITAL OTHER		
143	M	62	U	26	F	VENTRICULAR SEPT		
144	M	55	U	29	M	VENTRICULAR SEPT		
145	M	39	U	26	M	VENTRICULAR SEPT	CARDIOV. OTHER	

TABLE 13

LOGISTIC REGRESSION EQUATION FOR THE HEALTH EFFECTS OF ANAESTHETICS EXPOSURE - RANDOM SAMPLE VERSUS NON-EXPOSED

	REGRESSION COEFFICIENTS (P-VALUE IN PARENTHESES)									
Health Effect	Intercept	Anaesthetics Exposure	Age	Sex	Medication	Drinking	Smoking	OCCN1	OCCN2	Model p-value
Cancer/ Leukemia	-3.88	-0.44 RR=0.64 (0.13)	-0.002 RR=0.99 (0.82)	-0.64 RR=0.52 (0.10)	0.53 RR=1.70 (0.12)		0.14 RR=1.15 (0.58)	0.81 RR=2.26	-0.37 RR=0.68	0.16
Liver Problem	-4.79	0.10 RR=1.11 (0.72)	0.006 RR=1.00 (0.63)	0.47 RR=1.61 (0.13)	0.84 RR=2.33 (0.01)	-0.18 RR=0.82 (0.59)				0.11
Kidney Problem	-3.07	-0.02 RR=0.97 (0.89)	-0.002 RR=0.99 (0.77)	-0.12 RR=0.88 (0.56)	0.61 RR=1.85 (0.01)	-0.21 RR=0.80 (0.31)				0.09
Other Health Problem	-2.20	-0.13 RR=0.87 (0.10)	0.02 RR=1.02 (0.00)	-0.61 RR=0.54 (0.00)	0.95 RR=2.60 (0.00)	-0.05 RR=0.94 (0.59)	0.19 RR=1.22 (0.01)			0.0

Variable Range:

Anaesthetics exposure: 0=non-exposed
1=exposed

Age: 18-77 years (15-76 for cancer/leukemia)

Sex: 0=female
1=male

Medication: 0=no medication taken
1=medication was taken for relaxation, sleep or kill pain

Drinking: 0=not drinking
1=social drinking

Smoking: 0=not smoking, ever
1=smoking, ever

OCCN1, OCCN2: Occupational Group
Doctor: OCCN1=1, OCCN2=0
Nurse: OCCN1=0, OCCN2=1
Other: OCCN1=0, OCCN2=0

TABLE 18

LOGISTIC REGRESSION EQUATIONS FOR THE EFFECT OF ANAESTHETICS ON SPONTANEOUS ABORTIONS

MODEL #	INTERCEPT	ANAS EXPOSURE	BIRTH ORDER	AGE OF MOTHER AT PREGNANCY	SMOKING DURING PREGNANCY	PREVIOUS SPONTANEOUS ABORTION	OCCN 1	OCCN 2	MODEL P-VALUE
1	- 2.83	0.44 RR=1.55 (0.00)	- 0.002 RR=0.99 (0.95)	0.01 RR=1.01 (0.13)	0.06 RR=1.07 (0.27)	0.92 RR=2.50 (0.00)	- 0.28 RR=0.74 (N.S)	- 0.01 RR=0.98	0.00
2	- 2.13	0.50 RR=1.66 (0.0005)	- 0.05 RR=0.94 (0.32)	- 0.01 RR=0.99 (0.56)	0.06 RR=1.06 (0.53)	1.05 RR=2.87 (0.00)	- 0.17 RR=0.84 (N.S)	0.01 RR=1.01	0.00
3	- 3.02	0.83 RR=2.30 (0.00)	0.05 RR=1.05 (0.15)	0.007 RR=1.01 (0.57)	- 0.08 RR=0.92 (0.29)	0.62 RR=1.86 (0.00)	- 0.67 RR=0.51 (Sig)	- 0.15 RR=0.85	0.00
4	- 3.30	1.00 RR=2.72 (0.00)	- 0.001 RR=0.99 (0.98)	0.02 RR=1.02 (0.19)	- 0.10 RR=0.89 (0.42)	0.57 RR=1.77 (0.01)	- 0.88 RR=0.41 (Sig)	- 0.35 RR=0.70	0.00

Key:- RR = Relative risk: the ratio of the rate of disease among an exposed group compared with a non-exposed group.

Variable Range:

ANAS exposure:
Non-exposed = 0
Exposed group = 1

Birth order: 1-14
Age of mother at pregnancy: 14-46

Smoking during pregnancy :
0 = none
1 = under 20 cigarettes 1 day
2 = over 20 cigarettes 1 day

previous spontaneous abortion :
0 = none
1 = had previous spontaneous abortion.

Occupation:
Doctor OCCN 1 = 1
OCCN 2 = 0
Nurse OCCN 1 = 0
OCCN 2 = 1
Other OCCN 1 = 0
OCCN 2 = 0

Model #1: Female expposed vs female non-exposed
Model #2: Female random sample vs female non-exposed
Model #3: Male exposed vs male non-exposed
Model #4: Male random sample vs male non-exposed

TABLE 28

Distribution of Halothane TWAs by Occupation and by Sex (continued)

Occupation	Sex	# of Workers	Halothane TWA (ppm) Min.	Max.	Mean	S.D.	Median
Dentist	Unknown	1	0.4	0.4	0.4	—	0.4
"	M	2	0.1	2.3	1.2	1.5	1.2
"	All	3	0.1	2.3	0.9	1.2	0.4
Hospital Technician	F	1	0.05	0.05	0.05	—	0.0

TABLE 13

LOGISTIC REGRESSION EQUATION FOR THE HEALTH EFFECTS OF ANAESTHETICS EXPOSURE - RANDOM SAMPLE VERSUS NON-EXPOSED

Health Effect	REGRESSION COEFFICIENTS (P-VALUE IN PARENTHESES)									Model p-value
	Intercept	Anaesthetics Exposure	Age	Sex	Medication	Drinking	Smoking	OCCN1	OCCN2	
Cancer/ Leukemia	-3.88	-0.44 RR=0.64 (0.13)	-0.002 RR=0.99 (0.82)	-0.64 RR=0.52 (0.10)	0.53 RR=1.70 (0.12)		0.14 RR=1.15 (0.58)	0.81 RR=2.26	-0.37 RR=0.68	0.16
Liver Problem	-4.79	0.10 RR=1.11 (0.72)	0.006 RR=1.00 (0.63)	0.47 RR=1.61 (0.13)	0.84 RR=2.33 (0.01)	-0.18 RR=0.82 (0.59)				0.11
Kidney Problem	-3.07	-0.02 RR=0.97 (0.89)	-0.002 RR=0.99 (0.77)	-0.12 RR=0.88 (0.56)	0.61 RR=1.85 (0.01)	-0.21 RR=0.80 (0.31)				0.09
Other Health Problem	-2.20	-0.13 RR=0.87 (0.10)	0.02 RR=1.02 (0.00)	-0.61 RR=0.54 (0.00)	0.95 RR=2.60 (0.00)	-0.05 RR=0.94 (0.59)	0.19 RR=1.22 (0.01)			0.0

Variable Range:

Anaesthetics exposure: 0=non-exposed
1=exposed

Age: 18-77 years (15-76 for cancer/leukemia)

Sex: 0=female
1=male

Medication: 0=no medication taken
1=medication was taken for relaxation, sleep or kill pain

Drinking: 0=not drinking
1=social drinking

Smoking: 0=not smoking, ever
1=smoking, ever

OCCN1, OCCN2: Occupational Group
Doctor: OCCN1=1, OCCN2=0
Nurse: OCCN1=0, OCCN2=1
Other: OCCN1=0, OCCN2=0

TABLE 18

LOGISTIC REGRESSION EQUATIONS FOR THE EFFECT OF ANAESTHETICS ON SPONTANEOUS ABORTIONS

MODEL #	INTERCEPT	ANAS EXPOSURE	BIRTH ORDER	AGE OF MOTHER AT PREGNANCY	SMOKING DURING PREGNANCY	PREVIOUS SPONTANEOUS ABORTION	OCCN 1	OCCN 2	MODEL P-VALUE
1	- 2.83	0.44 RR=1.55 (0.00)	- 0.002 RR=0.99 (0.95)	0.01 RR=1.01 (0.13)	0.06 RR=1.07 (0.27)	0.92 RR=2.50 (0.00)	- 0.28 RR=0.74 (N.S)	- 0.01 RR=0.98	0.00
2	- 2.13	0.50 RR=1.66 (0.0005)	- 0.05 RR=0.94 (0.32)	- 0.01 RR=0.99 (0.56)	0.06 RR=1.06 (0.53)	1.05 RR=2.87 (0.00)	- 0.17 RR=0.84 (N.S)	0.01 RR=1.01	0.00
3	- 3.02	0.83 RR=2.30 (0.00)	0.05 RR=1.05 (0.15)	0.007 RR=1.01 (0.57)	- 0.08 RR=0.92 (0.29)	0.62 RR=1.86 (0.00)	- 0.67 RR=0.51 (Sig)	- 0.15 RR=0.85	0.00
4	- 3.30	1.00 RR=2.72 (0.00)	- 0.001 RR=0.99 (0.98)	0.02 RR=1.02 (0.19)	- 0.10 RR=0.89 (0.42)	0.57 RR=1.77 (0.01)	- 0.88 RR=0.41 (Sig)	- 0.35 RR=0.70	0.00

Key:- RR = Relative risk: the ratio of the rate of disease among an exposed group compared with a non-exposed group.

Variable Range:

ANAS exposure:
Non-exposed = 0
Exposed group = 1

Birth order: 1-14
Age of mother at pregnancy: 14-46

Smoking during pregnancy :
0 = none
1 = under 20 cigarettes 1 day
2 = over 20 cigarettes 1 day

previous spontaneous abortion :
0 = none
1 = had previous spontaneous abortion.

Occupation:
Doctor OCCN 1 = 1
OCCN 2 = 0
Nurse OCCN 1 = 0
OCCN 2 = 1
Other OCCN 1 = 0
OCCN 2 = 0

Model #1: Female expposed vs female non-exposed
Model #2: Female random sample vs female non-exposed
Model #3: Male exposed vs male non-exposed
Model #4: Male random sample vs male non-exposed

TABLE 28

Distribution of Halothane TWAs by Occupation and by Sex (continued)

Occupation	Sex	# of Workers	Halothane TWA (ppm) Min.	Max.	Mean	S.D.	Median
Dentist	Unknown	1	0.4	0.4	0.4	—	0.4
"	M	2	0.1	2.3	1.2	1.5	1.2
"	All	3	0.1	2.3	0.9	1.2	0.4
Hospital Technician	F	1	0.05	0.05	0.05	—	0.0